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SCHOOL SCIENCE AND MATHEMATICS

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School Science and Mathematics

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SCHOOL SCIENCE AND MATHEMATICS

VOL. XLII OCTOBER, 1942 WHOLE NO. 369

ATTEND THE 1942 CONVENTION IN CHICAGO

The Central Association of Science and Mathematics Teachers will hold its 42nd annual convention in the Hotel Morrison in Chicago on November 27 and 28, 1942. The Officers of the Association feel that in this national emergency the Association has a definite part to play in the service of our country. Many of its members will embody that spirit by serving in some branch of the Armed Forces. Others will utilize their technical training by taking an active part in Civilian Defense. Still others will make their contributions in the training of youth in sciences or mathematics. All the various activities and contributions of the members of the Association should form an integral part of discussions and deliberations at the annual convention.

Consequently, the 1942 Convention is to be devoted to a reaffirmation of our faith in the American Way of Life; to an analysis of our educational weaknesses in order that we may eliminate or correct them; to initiating definite plans for the conservation of our resources, that is, the natural material wealth, our social heritage, and the health of our people, and for the efficient utilization of them both in the attainment of victory and in the preservation of peace.

The Executive Board of the Association has contacted prominent educators and authorities in specialized scientific fields and has offered them significant places in the programs of the convention as lecturers at the general sessions and as leaders in discussions and as speakers at the sectional meetings. Most of our speakers are actively engaged in the services of the Government and their consent to attend our convention is but an added manifestation of their willingness to make further contri-

butions to our combined efforts in the service of our country.

The Association is indeed fortunate to have among its guest speakers the following prominent educators and scientists. Professor Ralph W. Tyler, chairman of the Department of Education, the University of Chicago, who will speak on "The Role of Education in Our Present Emergency." Professor Paul B. Sears, Oberlin College, who will present "The Role of Conservation in Our Present Emergency." Professor William L. Hart, the University of Minnesota, whose lecture is entitled "The Nation Calls for Mathematics." Professor B. S. Hopkins, the University of Illinois, who will discuss "The Role of Metallic Elements in Our Present Emergency." Professor Emeritus Anton J. Carlson, the University of Chicago, the guest speaker at the annual luncheon, whose subject is "The Teachers of Science and Mathematics and the Present Crisis."

In addition to the general sessions of the Association, the Chairmen of the various sections and groups have arranged programs for the Friday afternoon section meetings and Saturday morning group meetings which embody the theme of the Convention, namely, "Correcting Educational Weaknesses for Future Strength."

Every member of the Association should make a special effort to attend the 1942 Convention. It is at our annual convention that we can collectively embody the spirit of the Association which has for forty-two years fostered sound educational principles in the teaching of sciences and mathematics. The application of these principles is urgently needed today, when our country calls for sound technical, scientific, and mathematical training of the youth of the land.

Every member of the Association should urge teachers of sciences and mathematics who are not members of the Association to attend the 1942 Convention as guests of the Association. The Nation needs our combined efforts. Let us meet together, talk over our common problems, and initiate plans to correct whatever educational weaknesses we have had in the past and build for future strength.

The *Yearbook*, which contains complete convention information, will be sent to the members of the Association. Others may have copies of the *Yearbook* by writing to the Editor, Professor J. E. Potzger, Butler University, Indianapolis, Indiana.

JOEL S. GEORGES, *President*

NECROLOGY

To further the policy of personal touch among its scattered membership the journal will from time to time publish brief accounts of the departed members of the Central Association of Science and Mathematics Teachers.

Horton Kline, Central High School, LaCrosse, Wisconsin. Died February 1942. Mr. Kline was a mathematics teacher and had been a member of The Central Association of Science and Mathematics Teachers since 1916.

Harry A. Carpenter, West High School, Rochester, New York. Died April 5, 1942. Mr. Carpenter was author of several text books and active in science and mathematics associations including our own. He was a member of our journal staff for many years.

Bryon J. Rivett, Northwestern High School, Detroit, Michigan. Born 1879, died January 19, 1942. Mr. Rivett a former chemistry teacher and author of chemistry books was principal of Northwestern high school from 1920 until the time of his death. Mr. Rivett attended college at Michigan, Chicago and California.

Homer P. Yutzey, Western High School, Detroit, Michigan. Born 1883, died March 30, 1942. Mr. Yutzey, a mathematics teacher was long a member of The Central Association of Science and Mathematics Teachers and a frequent attendant at meetings. Mr. Yutzey attended college at Michigan, Michigan State, Columbia and Chicago.

W. H. Clark, Kelley High School, Chicago, Illinois. Died January 6, 1942. Mr. Clark, a mathematics teacher of Lindblom, Crane, and Kelley High Schools of Chicago, completed the work for his Masters degree at University of Southern California. Extracts from his thesis were published in this Journal about two years ago.

W. F. Roecker, Boys' Technical High School, Milwaukee, Wisconsin. Born 1880, died September 13, 1942. Mr. Roecker, a teacher, author, and business man was head of the Science Department of his school for many years. For the past fourteen years he was Business Manager of SCHOOL SCIENCE AND MATHEMATICS.

ELEMENTARY SCIENCE—WHERE IS IT GOING?

WALTER A. THURBER and R. E. BOWERS
New York State Teachers College, Cortland, New York

Some fifty years ago, science began to make its way into the elementary schools under the name of "Nature Study."

The term, "Nature Study," rather than "Science," was probably chosen deliberately by the originators of the movement. These people, though perhaps unable to figure a coefficient of reliability, were teachers, teachers in the highest sense of the word. They knew instinctively (or was it because they actually knew children?) that the highly formalized science of college had no place in the elementary classroom.

The motive underlying Nature Study was "Observe the things about you, consider them, but be cautious in making general statements." The emphasis was to be upon actual observations, supplemented by some reading.

Nature Study came to concentrate chiefly upon the biological aspects of science, possibly because many of its leaders were better trained in biological science. However, such was not the intention of the founders of the movement; early writings and early courses of study show a balanced distribution of the different fields. Later, increased interest in the technological aspects of science showed up the inadequacy of the purely biological interpretation of nature study.

A really regrettable trend in nature study was due to well-meaning, but overly sentimental people. These gushing souls gave to plants and animals human characteristics and filled the literature with rhapsodies on "Old Mother Nature." Realistic folk rebelled. At about the same time, the popular excitement over "Nature Faking" did the nature study movement no good.

So there came into the curriculum the course known as "Elementary Science." This term was almost certainly chosen because it implied the antithesis of what nature study had come to mean to many.

The motive underlying Elementary Science was "Observe the things about you, consider them, but be cautious in making general statements." The emphasis was to be upon actual observations, supplemented by some reading.

Elementary science, like nature study before it, has now fallen into the hands of another well-meaning, but incompetent group.

These people, interpreting the term "science" in its narrowest sense and ignoring the "elementary" part of the title, have built up overly-ambitious and highly formalized programs based upon materials far beyond the experiences, needs and abilities of elementary pupils.

To make matters worse, our elementary school teachers and most of those in teacher-training institutions are not qualified to teach a program which deals with generalities in many varied fields. Only in the larger universities, where specialists in many fields cooperate, can highly-generalized orientation courses be safely given.

Many leaders in elementary science have not recognized this basic fact. And so courses of study in elementary science, and texts to accompany them, are being developed by people who are not qualified to do so. These courses of study and these texts are being filled with absurd statements and with ridiculous activity-suggestions.

Some of the simplest principles of science education are being ignored. Pupils are not taught to collect their data by first-hand observations, to consider these data carefully before making generalizations, or to use books and pictures with caution. Instead, their attention is centered upon principles and theories not yet accepted by outstanding scientists, and their data-collection is confined almost completely to books and pictures, many of which are the work of people not well qualified to produce them.

Let us examine some of the courses of study and some of the texts in elementary science that have come out in the last few years.

Here is a course of study that suggests for the third grade a study of the nebular hypothesis, the geological history of the world, and the origin and evolution of life. The sixth grade of this outline goes into these same topics in greater detail and spends the entire year upon then. Archaeopteryx receives flattering attention but robins are ignored; dinosaurs are studied in considerable detail but woodchucks are completely forgotten.

A text, based upon another outline, instructs first grade pupils about conditions on the moon. Sixth graders study about comets, galaxies and spiral nebulae. One of the activities suggested by the outline is the making of a model of a galaxy—on a bicycle wheel!

The molecular and electronic theories are now deemed suit-

able for the elementary science program. In one outline, fourth grade pupils receive their introduction to electrons with an ingenious, but somewhat uncertain analogy in which pieces of chalk are passed around a circle to simulate an electric current. Another outline brings in the study of molecules for the fifth grade with the suggestion, "Boil water to show motion of the molecules." In a recent test, a knowledge of the molecular structure of water is considered a prerequisite to a knowledge of the moisture-gathering function of plant roots.

High school chemistry has begun to move bodily into the grades. Pupils are expected to know the difference between "solids, liquids, gases and gels," and between "elements, compounds and mixtures." Physical chemists themselves would welcome such information, although it is doubtful if they would value it from individuals who say that the escape of ammonia from ammonia water is an example of evaporation.

Pupils are asked some very interesting questions, "Do you think all of the stars in the Big Dipper are the same distance from the earth?" "Can we see all of the universe with even the biggest telescope?" "Make a theory to explain why the great reptiles of the past disappeared."

It would seem that elementary science is reaching into some very uncertain fields, but elementary science educators do not seem at all disturbed. One science supervisor, who has written a text, blithely, but somewhat naïvely, writes that elementary teachers need only to sit down "on an evening or so" with some good book such as the *Nature of the World and Man* in order to establish a satisfactory background for the teaching of elementary science.

It does seem that elementary science has reached an extreme far worse than anything that could be attributed to nature study. Nature study dealt with things that could be seen and handled, but the present trend is certainly into the unknown. At the present rate it is not too much to expect that in another ten years sixth graders will talk glibly of atomic disintegration, third graders of radioactivity, and first graders of the expanding universe.

What about the development of the powers of observation, the encouragement of critical thinking, the development of the ability to generalize cautiously? How does study of the Archaeozoic Era and the living conditions on Pluto give practice in meeting these aims? And what about the old-fashioned idea

that pupils must have an adequate experience background before they can appreciate ideas far removed from themselves? Are all these to be discarded?

It seems as though the time has come when we must again stop one of the the wild gyrations that curse science teaching. We might change the name again, but after all, the name is a good one. The only real change needed is a return to time-proven principles, "*Observe the things about you, consider them but be cautious in making general statements. Emphasize actual observations and supplement them with a little reading.*"

A LABORATORY APPROACH TO INTERMEDIATE ALGEBRA

JAMES W. BEACH
Dubuque University, Dubuque, Iowa

In order that the pupils might have a glimpse of the reasons for including what is included in "Intermediate Algebra," this class was started this year with some laboratory experiments. One group conducted a "Hooke's Law" experiment, another a "Law of Levers" experiment, a third was told to look at a butcher's scale and report what they saw and a fourth found the census figures for the population of Iowa since its statehood. These groups then reported in class and their reports were discussed.

The discussion of the report on the observation of a modern weighing device led us to the conclusions that: a) they had seen the practical application of a table; b) the person buying had to use a formula or formulas to find the prices and these formulas are equivalent to the table; c) the information in the table could be expressed in a verbal statement for which the formula was a shorthand expression. These conclusions were not presented by the teacher, but were brought out in a class discussion directed by the teacher. From these exact data we went to a discussion of Hooke's Law. In trying to present these data clearly the group used a table, then a graph and these led to the verbal statement and the equation. Thus the pupils had seen the same quantative data presented as a table, a graph, a formula and verbal statement. For the next meeting the pupils were asked to try expressing their data in the four ways discussed.

The failure of the population figures to conform to a formula

was brought up at the next meeting even before the clock said class was in session. This had been expected; so we discussed statistics briefly. Then we brought out the fact that although all the data with which we were working were quantative, some were most useful as a table, some as a formula, and some as a graph, but all were expressions of a functional relationship and this relationship could be expressed in several ways. This fact was emphasized in the lessons that followed. Those who experimented with levers were not forgotten. They reported and while the report was not immediately discussed it was used as soon as we began studying more thoroughly each type of representation brought out.

This course expanded from this view of representing quantative relationships to a study of the table, the graph, the formula and the operations on a formula, or more generally, the equation. Thus an attempt was made to unify the course and show the reason for all of these weeks of studying skills.

At the end of six weeks a test was given which showed that most of the pupils still could not see above the details of plotting graphs, changing verbal statements to formulas and vice versa and the axioms for solving equations. However, 32% definitely saw an interrelationship between all parts of the work. That was 32% more than had that understanding from the first six weeks work last year; so the results were encouraging.

WORKSHOPS FOR JUNIOR COLLEGE TEACHERS

Attracting nationwide attendance, the second annual workshops on junior college terminal education were held this summer at the University of California, the University of Chicago, and Harvard University. The third and last of this series of workshops will be held in the summer of 1943.

Designed to "teach the teachers" so that they may adapt the increasingly popular two-year terminal courses most effectively to the needs of junior college students, the workshops have become especially valuable to instructors during wartime faced as they are with the educational race-against-time. The workshops have been sponsored by the American Association of Junior Colleges through its Commission on Junior College Terminal Education and have been operating under a grant from the General Education Board.

Directors of the three workshops this summer were as follows: California—Rosco C. Ingalls, director of Los Angeles City College; Chicago—Leonard V. Koos, professor of education, University of Chicago; and Harvard—Byron S. Hollinshead, president of Scranton-Keystone Junior College, LaPlume, Pa.

SEMI-MICRO QUALITATIVE ANALYSIS FOR HIGH SCHOOL STUDENTS

WELKER BECHTEL[1] and JOHN A. FISHER
Boone High School and Junior College

For several years the authors have offered work in qualitative analysis as a part of the second semester course in high school chemistry. The objectives and scheme of analysis used have already been published.[2] Because of increasing difficulty in replenishing supplies of chemicals it was considered advisable this year to conserve our supply to make it last as long as possible. Qualitative analysis carried out according to the usual methods requires the use of large amounts of chemicals. Rather than curtail laboratory work drastically the authors decided to change the qualitative analysis to the semi-micro scale.

Students were supplied with home-made test tube racks made from two pound wooden cheese boxes reconstructed as shown, with the holes for test tubes five-eighths inch in diameter. The boxes were brought by students. In addition to the usual locker equipment each student was issued the following:

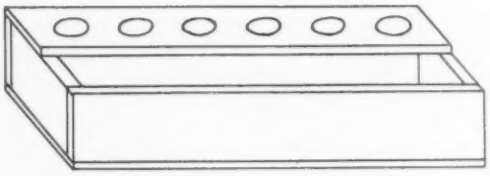
8 Oklahoma beakers, 63×13 mm.
3 centrifuge tubes, 5 ml., tapered
4 Porcelain crucibles, size 0
1 nickel spatula
6 tapered stirring rods, 6 in. long
2 Erlenmeyer flasks, 50 ml.
1 micro tube brush
6 home-made medicine droppers with glass tubes 4½ in. long. Rubber bulbs were purchased. (Regular length droppers do not reach to the bottom of the 5 ml. centrifuge tubes.)
1 enameled pan for storing equipment

Filtrations were eliminated by use of electrically driven centrifuges capable of holding 3 ml. or 5 ml. tubes. The laboratory was equipped with two, and these proved ample for sections of 26 students. The usual bottles were used for solid reagents, and students were instructed to pour onto a watch glass for their use an amount the size of a grain of wheat. Liquid reagents were in Barnes dropping bottles of 30 ml. capacity, and there were two complete sets in the laboratory except for the common acids and bases. Of these each student had a set. While micro burners are desirable they are not a necessity and our work has done with regular Bunsen burners adjusted to give a low flame.

[1] Now located at Iowa State College, Ames, Iowa.

[2] Bechtel, Welker and Fisher, John A., "Qualitative Analysis for High School Students," SCHOOL SCIENCE AND MATHEMATICS, XLI, pp. 647–656, October, 1941.

The scheme of analysis previously referred to proved easily adaptable to the new scale. Quantities of samples and reagents were taken in proportion to the amounts called for. One-tenth as much was used. All heating of solutions was done in crucibles. Where the outline called for filtering, centrifuging was substituted.



A Homemade Test Tube Rack

For those teachers of high school chemistry who have not studied the semi-micro method there are many good college texts available now in this field, and the new technique can be learned readily.

Results were entirely satisfactory. The amount of chemicals used were cut to less than one-fourth. Breakage of most items was negligible. The small equipment stands mechanical shock much better than do the larger sizes. One item in which breakage was serious was centrifuge tubes. The tapered ends are easily broken during stirring or cleaning. Centrifuging can be done in Oklahoma beakers or small test tubes in place of the more expensive centrifuge tubes.

Because of the small amount of chemicals used there was no problem due to fumes. At no time was there more than a faint odor in the laboratory. The authors believe that there will be a material saving in plumbing repairs and in the corrosion of metal equipment in the room.

More work was accomplished per laboratory hour because of the saving in time of centrifuging instead of filtering. All precipitates which were obtained could be separated from the solution in two minutes by centrifuging, and each washing of a precipitate required only a brief stirring followed by centrifuging. Students had no difficulty in recognizing precipitates in the very small amounts obtained, and the proportion of correct analyses was high. It seemed that students used greater care and precision in their work than did former classes which used the macro method.

IGUAZÚ FALLS, SOUTH AMERICA

MINNIE E. LEMAIRE
State Teachers College, La Crosse, Wisconsin

Waterfalls, because of their inherent characteristics, lend themselves well to two particular uses, as a source of power and as a source of pleasure. With the increased industrialization of South America and the relative lack of coal as a fuel resource much interest devolves upon both petroleum and water as potential sources of power. In regard to the latter, the Iguazú

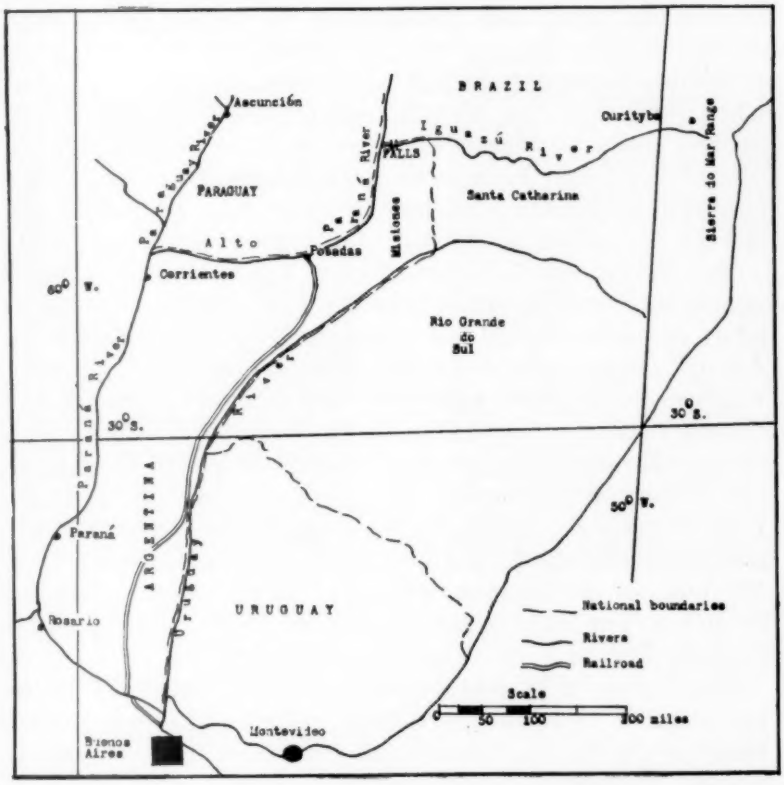


FIG. 1. Iguazú Falls and its contiguous territory.

Falls of Brazil and Argentina (Fig. 1) attract much attention and consideration. The location of these falls far in the interior (800 miles north of Buenos Aires) and in a region of sparse population has meant that people generally regard them as hav-

ing little value for industrial purposes. Today the location of factories and power sites in the interior portions of a country is considered sound, particularly from the point of view of defense. The value of these great falls for sightseeing has been acknowledged but so far has not been sufficiently stressed by the countries wherein they are located.

Just when the Falls were first visited remains questionable. Apparently the first authentic mention of this great natural phenomenon came from Padré Lozana in 1767. Evidence of a visitation by Núñez Cabeza de Vaca to this area in 1542 has been well substantiated. Emperor Charles V permitted him to lead an expedition from Cadiz, Spain, to the Rio de La Plata country and the region to the north. These early notations practically disappeared from sight and were forgotten until 1863 when Father Patimo, after exploring the Alto Paraná River section, again called people's attention to the Falls of Iguazú. Since this period, the Falls have come increasingly to the fore and have been visited by hundreds of tourists, many of whom call the United States, "home."

The Iguazú (which is Guarani for "Great Waters") River rises in the Curityba Hills of the Sierra do Mar Range in Brazil at an elevation of 3000 feet, approximately 30 miles from the Atlantic Ocean. From the source to the mouth, at the junction with the Paraná River, the river receives water from some 30 tributary streams, such as the Rio Negro and Rio Chopim, and covers a distance of slightly more than 800 miles. The major portion of the river, some 745 miles, flows in Brazilian territory, while 75 miles of it forms the boundary line between Argentina and Brazil. The upper portion of the river lies in a district of 100 inches of precipitation, while the lower portion receives but 80 inches. The Falls proper are located 11–12 miles upstream from the Paraná River (Fig. 2).

The Plateau of Misiones, through which the river cuts in the last stage of its journey is slightly arched and deeply cut by many young valleys. The plateau consists of red sandstone of Triassic age covered in many places by ledges of dark basalts of Tertiary age which run counter to the general direction of the valleys. These ridges of hard rocks, which do not erode rapidly in comparison to the sandstone, determine the position of the falls of the streams tributary to the Paraná River and particularly the cataracts of the Iguazú River.

The river, just above the Falls, appears to be almost a lake

and varies in width from one-half a mile to almost a mile (Fig. 3). At the precipice the river opens up to the contour of a semicircle which stretches 4000 yards in perimeter. In comparison, the Niagara Falls of the United States and Canada are one-half of the width, and the Victoria Falls of Africa are two-thirds. The flow of the river divides into two main channels, one to the north for the Garganta del Diable (Devil's Throat) and the other to the south for the cataracts of San Martin. All of the 4000 yards do not have water flowing over them but rather there are many individual cataracts, all of which have specific names, such as Salto Belgrano, Salto Floriano and the Three Musketeers.

FIG. 2. A view of the Iguazú River gorge looking upstream toward the Cataracts of the Iguazú of Argentina.

FIG. 3. Garganta del Diable Falls. In the background note lake out of which the water pours.

The Falls attain a total height of approximately 225 feet at average flow. The water, however, does not in general plunge this whole distance in one leap, for the river has been eroding the top layers of the rocks faster than the lower portions, thus forming ledges or projecting platforms. On the Brazilian side, for instance, the Falls consist of two component parts. First, the water leaps 100 feet to a platform, which varies in width from a few yards to over 50 feet, and then plunges another 100 feet to the bottom of the gorge (Fig. 4). During the flood season, which

has its peak in October and lasts 2 to 3 months, the whole region may appear as a single fall.

Estimates of the volume of water, flow, and horsepower vary greatly indicating a large amount of inaccuracy and a general lack of knowledge. The statistics used here seemed to be most reliable, for they do not appear overly optimistic, as many do, but average. At low water the Iguazú Falls have a volume of less than 10,000 cusecs (cubic feet per second), the lowest record showing no more than 7381 cusecs. In average flood the figure indicated was 167,498 cusecs. At extremely high flood, and this

FIG. 4. Falls on the Brazilian side. This is the upper portion of the falls and below is the ledge or platform which interrupts a total descent of the water at one time.

FIG. 5. The lower portion of a tree covered with parasitic plants and in the crotch, a delicate orchid.

only exceptionally, 459,029 cusecs, which is double that of Niagara, has been recorded. The mean annual flow really constitutes the best base on which to judge potential power. The mean flow at the Iguazú Falls is 1746 cubic meters per second or equivalent to 61,660 cusecs. In this respect the Iguazú Falls exceed Victoria Falls more than half as much again, and equal two-sevenths that of Niagara. The average flood flow of the South American Falls is twice that of the African Falls and almost equal that of the North American Falls. For 255 days of the year the calculations indicate a possibility of developing

1,214,807 horsepower, whereas during the low water stage no more than 182,491 horsepower could be assured.

The erratic nature of the volume of water may also be noted in the range of annual precipitation at either Curityba, Brazil or Posadas, Argentina. At Posadas, in 1905, 82 inches fell whereas in 1917 only 2.2 inches. The Curityba figures show a smaller range (in the period 1885–1925) with 75 inches in 1911 and 35 inches in 1924.

A situation, not encountered at Niagara, sometimes materializes which neutralizes any possible production of power because

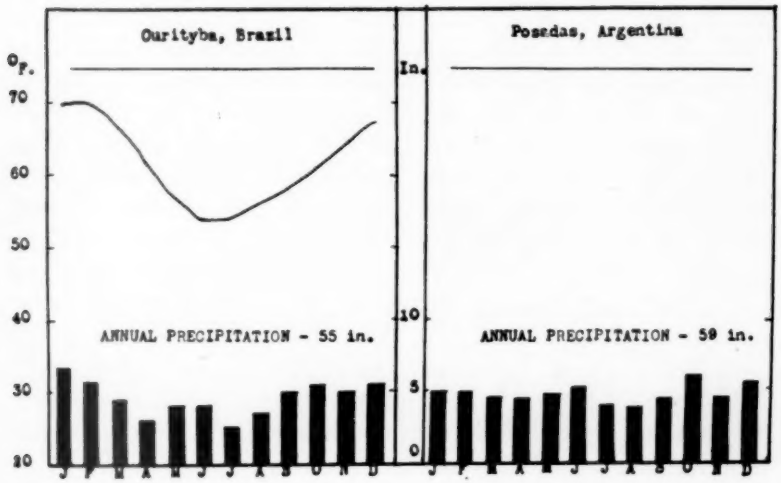


FIG. 6. Climatic charts for cities close to the Iguazú Falls. The tendency toward a winter minimum of precipitation explains why this season is most satisfactory for visitation by tourists.

the falls are eliminated. Generally the flood rise in the region is some 6 to 10 feet but at times it reaches 16 feet. However, in 1905 and 1929 the Paraná River rose so high that waters from the Iguazú River, forced to remain in the gorge, overflowed and inundated the surrounding region to such a degree the falls for all practical purposes disappeared.

The possibility of disagreement and trouble between the two countries, Brazil and Argentina, disappeared after preliminary surveys and agreements as to water rights had been made and accepted.

Although the utilization of the Iguazú Falls for power may be a thing of the future or even impossible, the recreational value

not only is excellent but should be increased and improved. Access to the area at present is by the Paraná River, either from Brazil or from Argentina, but most of the traffic comes from Buenos Aires with two alternate routes from which to select. First, there is the all water route; the second is a combination route, by train from Buenos Aires to Posadas and then by river steamer to Puerto Aguirre which is located a half mile up the Iguazú River. (See Mabel V. Wood, "The Paraná Way to the Iguazú Falls," *Journal of Geography*, XXX, 205–218.) The best time to visit the falls is the season from March to September when the water is at its lowest levels and the individual falls are visible (Fig. 6).

The tumultuous roar of the cataracts greets the visitor as he draws near the hotel and extends a forceful and meaningful welcome. From the immediate neighborhood of the Falls there rises a great mist which may float down the great gorge as it did on our visit. This mist often clouds the Falls and prevents the best view of them but fortunately on the night of our arrival a heavy shower came up, cleared the air, and made visibility excellent. On approaching the river the magnificent gorge first holds one's attention and then, the Falls! At this instant all doubt disappears and all agree that the Iguazú Falls constitute a marvelous vista of grandeur and of rare and noble beauty.

But one should not be content with the falls alone because the surrounding region offers much of interest. For everyone, and especially a geographer, the vegetation has much value (Fig. 5), and if one can manage a horseback trip for a couple of hours, the visit can be greatly enhanced. For the naturalist, much fun can be derived from a study of the many beautifully colored butterflies which are indigenous to this tropical setting.

With the celebration, this year 1942, of the 400th anniversary of the discovery of the Falls, it seems quite appropriate to forecast, in this coming era of rediscovery, a more important and interesting future for the Iguazú Falls.

BIBLIOGRAPHY

Rashleigh, E. C. *Cuarto Centenario del Descubrimiento de Las Cataratas del Iguazú*, La Prensa, Buenos Aires, Jan. 1, 1942. 4th section.

Denis, P. *Geographie Universalle. Tome 15. Amerique Du Sud.* Part 2, pp. 423–424.

Kühn, Troz, *Fundamentos de Fisographia Argentina, Talleres Graficos.* P. Preusche, Buenos Aires, 1922.

Levene, Ricardo, *A History of Argentina*, University of North Carolina Press, Chapel Hill, 1937. p. 24.

Noyes, T. W., "The World's Great Waterfalls," *Nat. Geog.*, L (1926) pp. 29–59.

Rashleigh, E. C., *Among the Waterfalls of the World*, Jarrolds, London, 1935, Chap. 3.

Windhausen, Anselmo, *Geologia Argentina*, Vol. 1 and 2, Jacobo Peuser, Lda., Buenos Aires, 1929.

PHOTOGRAPHIC AIDS TO TEACHING

I. PHOTOGRAPHIC ENLARGEMENTS FOR CLASSROOM USE

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The great success of *Life* and other pictorial magazines is an indication of the effect of the photograph on the public mind. This medium ought to be utilized to a greater extent in the science classroom. Lantern slides have been in general use for many years, but their usefulness is limited by the need for an expensive projector and by the necessity for darkening the room. We have found that photographs, if enlarged to sufficient size, are extremely effective visual aids for science classes.

One can obtain photographic paper in large rolls or in cut sizes up to 16×20 inches, but the 11×14 inch size is most readily handled in the usual photographic darkroom. The cost of an 11×14 inch print, including the negative, is about fifteen cents. An enlargement of these dimensions can be seen very clearly from all parts of the classroom. Visibility will be enhanced if a high contrast emulsion is chosen. Paper with a glossy surface is best, but ferrotyping is to be avoided, since the reflections may be disturbing. Subjects must be chosen carefully. The photograph must show clearly what is intended without the inclusion of confusing extraneous details. Some examples of situations in which such photographs may be used to advantage are:

1. Living plants and animals photographed in the field.
2. Experimental setups and results (photosynthesis, digestion, etc.)
3. Photomicrographs may be used in place of the microscope or microprojector.
4. Science applied to industry—Hydroelectric plants, chemical factories, radio installations, mining operations.
5. Portraits of great scientists.

6. Illustration of techniques to be used by students in the laboratory—such as wiring arrangements, distallation set-ups, etc.

Many additional subjects will suggest themselves to the enterprising teacher. One should be on the lookout for good material, especially while traveling. Photographs and diagrams in textbooks and reference books can readily be copied photographically and enlarged to the proper dimensions for classroom work. In fact, the pedagogical possibilities are almost limitless.

A student explains the processes of Maturation and Mitosis with the aid of a series of enlarged photomicrographs taken by the author from prepared slides of Ascaris eggs. The chromosomes, centrosomes, polar bodies and other details are plainly visible, although the camera was set up at the back of the classroom.

GOVERNMENT BUYS HUGE QUANTITIES OF CITRUS JUICES

Over a half million gallons of concentrated citrus juices have been ordered by the Government in Florida alone in an attempt to avoid scurvy outbreaks among the peoples at war due to vitamin C deficiencies.

Improved methods of processing the fruits have been developed here by the U. S. Citrus Products Laboratory. A large plant to be used for this purpose has just been completed for the U. S. Department of Agriculture. The concentrated juice is now being put into medicine bottles for rationing to British children.

By preparing the vitamin in concentrate in a special vacuum chamber a thick flavorful syrup is obtained which contains 85% of the original vitamin content.

A WORK SHEET FOR MIRRORS AND LENSES

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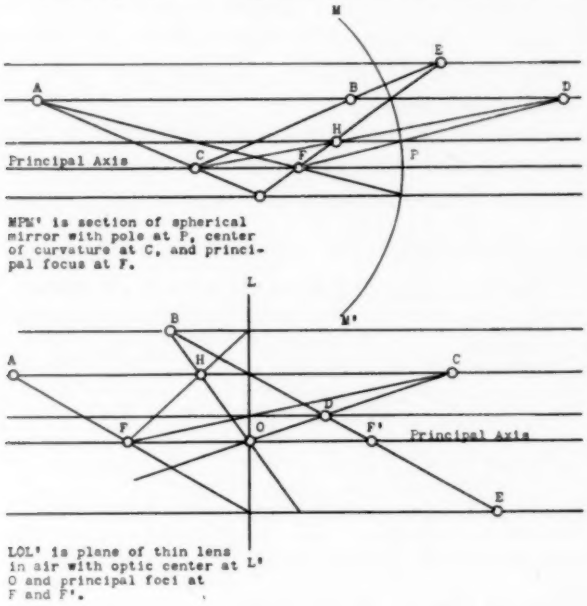
In Professor Taylor's recent text-book on physics credit is given at long last to Robert Smith, of Cambridge University, who, in 1738, invented the familiar "three ray" method of locating images in spherical mirrors and thin lenses. Beginners in physics need considerable practice in constructing ray diagrams, and should not be burdened with "special cases," such as those in which the image is at the principal focus, at the mirror, and



at the center of curvature. These may be treated qualitatively by the teacher. The author has, however, devised a skeleton diagram or "work sheet" which the teacher can prepare by hektograph process for his class in as large a quantity as he desires, and which is sufficiently exact so that the images "come out" where they should and not confuse the student by being off the page, etc. The diagram is to be accompanied with a table (shown herewith) in which the pupil is to substitute answers for the "image," stating the point on the diagram he has found to be conjugate to the point indicated under "object," and stating also whether or not the image thus found is real. These

twelve cases comprise the essentials of the elementary ray constructions. The teacher will point out that certain cases (e.g., 1 and 6; and 7 and 12) are geometrically identical. When preparing the diagram for hektographing, the actual "rays" are not drawn in; only the points A, B, C, D, etc., and the several lines which are parallel to the principal axis, are to be included. The student who is furnished with one of these skeleton diagrams, a ruler, and a pencil can run through all the cases readily. In order to avoid drawing one completed diagram over another, it is suggested that each pupil be given at least six work sheets.

To illustrate the use of this method, let us consider Case 4. The object is at D in front of a convex mirror, and the image will be at H, back of the mirror. To locate H the student will draw (i) a full line through D parallel to the principal axis, cutting the mirror, after which the ray is dotted (as virtual) through F; (ii) a full line from D to C; and (iii) a full line from D in the direction of F, to be reflected from the mirror back parallel to the principal axis, and, dotted backward, to intersect the two other rays

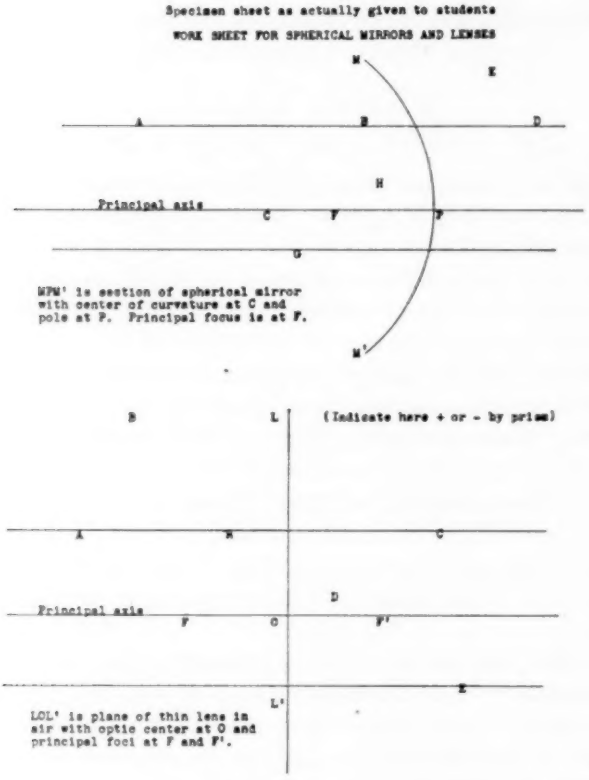
Specimen sheet as actually given to students:

PROBLEMS AND TABLES TO GO WITH WORK SHEET

Base	Optical Instrument	Direction of Light	Sign of f	Object	Image
1	Spherical Mirror	Left to right	+	Real (A)	
2	Spherical Mirror	Left to right	+	Real (B)	
3	Spherical Mirror	Left to right	+	Vir. (E)	
4	Spherical Mirror	Right to left	−	Real (D)	
5	Spherical Mirror	Right to left	−	Vir. (H)	
6	Spherical Mirror	Right to left	−	Vir. (G)	
7	Lens	Left to right	+	Real (A)	
8	Lens	Left to right	+	Real (H)	
9	Lens	Right to left	+	Vir. (B)	
10	Lens	Right to left	−	Real (C)	
11	Lens	Left to right	−	Vir. (D)	
12	Lens	Left to right	−	Vir. (E)	

behind the mirror at H. The converse problem is somewhat more difficult, viz., to treat H as a virtual object, and locate the real conjugate D, but the better students in the class will be able to solve this problem.

In conclusion, it is suggested that the teacher point out that a dental mirror is illustrated by Case 2, a truck rear-view mirror by Case 4, the telephoto lens by Case 11, and the eyepiece of the Galilean telescope by Case 12.



Be able to answer the following questions in your review:

1. Which case illustrates (a) shaving and dental mirror, (b) rear-view mirror for automobile, (c) ocular of Galilean telescope, (d) magnifying glass, (e) part of a telephoto lens system?
2. Show that for a distant object the size of an image is proportional to the focal length and that the *area* of the image is proportional to the *square* of the focal length.
3. Which mirror is (a) converging, (b) concave, (c) diverging, (d) convex?
4. Which lens is (a) converging, (b) concave, (c) diverging, (d) convex?

5. Trace a ray through a prism of refracting angle A so that ordinary deviation is illustrated.

6. Trace a ray through a prism of refracting angle A so that the deviation is a minimum. What conditions must be satisfied here? What special form does Snell's Law take in this case (*alone*)?

7. Draw a diagram to illustrate (a) aberration at a plane refracting surface, (b) spherical aberration by a (i) spherical mirror and by a (ii) lens.

8. Why are there in general two positions between the positions of object and image where a positive lens can be placed to satisfy the lens formula?

DETERMINING THE PLACE OF MATHEMATICS IN THE EDUCATIONAL PROGRAM

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Should mathematics be a part of the educational experience of every person, and if so, what is the minimum? Old questions and often debated with varying degrees of understanding, partisanship and heat. Whenever issue is joined, it is taken for granted that teachers of mathematics will defend mathematics for everybody and urge a high minimum. And our arguments and pleas will be discounted because, of course, we are not disinterested while those who oppose our point of view are disinterested. Not interested! That is precisely what teachers of mathematics cannot comprehend. But the more we urge, the more our exhortations are discounted, and so we get nowhere; at least, not until there is a national emergency with its demands for men with mathematical training. Then mathematics, like Tommy Atkins, is "savior of 'is country when the bands begin to play."

I wonder whether it would be possible for us teachers of mathematics to become disinterested about this matter and thereby gain an advantage long enjoyed by the general educationist. It may be that fundamentally we are more disinterested than we have been given credit for being. Let us resolve for the time being to forget the old arguments about mathematics being essential in so many practical situations and think of the broader aspects of educational values.

More important than any school subject is the ability to think. What is thinking? Let the psychologist define the act; but whatever else it may be, thinking involves the examination of every detail that has any bearing on the conclusion to be

reached. If this sounds too difficult and laborious, let it be said that much of the detail of the process of examination can and should be done subconsciously. Habit, if correctly established, can be relied upon to spare the thinker much of his labor. A good mind is like a good watch; if you listen, you can hear the ticking, but you cannot hear all the wheels turn. And so some of the steps in thinking will be taken consciously while others, equally essential, will be taken unconsciously. But the unconsciously performed processes must be as reliable as those consciously performed. Perhaps this is the chief characteristic of a good thinker. Now, let us admit that any training that develops the ability to examine every detail of a subject under consideration, that makes the subconscious processes of thought as reliable as those consciously performed is a valuable part of education. The important thing here is not the particular subject studied but the result attained. Will the study of Latin help? Will music help? Will mathematics help? What subject will do most to train for examination of every contributing detail pertaining to a question to be decided? If you can find a subject better fitted than mathematics to train for this important ability, by all means let it take its rightful place in the curriculum. And if mathematics gives the training necessary do develop this ability, then let it have a prominent place in every curriculum. Surely such a point of view is sufficiently neutral. But we may safely go a step further: We teachers of mathematics should be willing to let any competent person be the judge of the value of mathematics to train in this important ability.

Few persons interested in education would care to defend the negative of the proposition that one characteristic of every good citizen is that he learn to live according to commonly accepted rules. The rules may be written into the law books, or they may be part of the unwritten social code, or they may be in Hoyle's Book of Games, or they may be made for the guidance of those who play basketball, or baseball, or football, or they may be set up by religious organizations, or they may be regulations passed by the labor union, or they may be set up for the guidance of those in a fraternity or a lodge. Wherever there is organized society there are, there must be rules. Persons designated as antisocial are those who have not learned to live according to the accepted rules. They are misfits. They do some harm to society, but they do much greater harm to themselves. Education should do all it can to teach the adjustment that becomes in-

creasingly necessary for living as units of the society that no one can or would escape. The school curriculum makers must give full recognition to this necessity. What subjects will best teach living according to rule? Well, there is athletics with games played according to very definite rules and with employed officials to see that the rules are observed. Let there be more athletics for more participants. Then there are the sciences with laws written on every page, laws that man did not write and cannot alter. He can only order his own life to conform with the eternal laws and be successful and happy, or live in conflict with those laws and be unsuccessful and unhappy. By all means, let science come into its own in the curriculum. Let more people take more science, more botany, more zoology, more physics, more chemistry. Every subject that is well taught has its own definite laws. Has mathematics anything valuable to contribute to those who must learn to live according to rule and law? Is there a subject where the rules and laws are better established or where the results of violation bring quicker or more definitely observable contradiction and catastrophe? If mathematics can offer training in development of the ability to work according to law, let it be a part of the training of everyone. Again, let not the mathematician or the teacher of mathematics be the judge; we must be neutral. Let this matter be decided by anyone who is interested in training citizens to live according to rule and law.

Related to the necessity of learning to live according to law is the necessity which becomes more and more urgent to learn the language of law. There is a law which tells the air resistance encountered by a car traveling sixty miles an hour as compared with that encountered by a car traveling twenty miles an hour. To understand the law one must understand the language in which it is stated. There is a law which tells the true rate of interest when one buys on an "Easy Payment Plan." To understand this law one must first understand the language in which it is expressed. There is a law which tells how many offspring will result from the mating of two houseflies after the tenth generation (assuming certain factors). To understand this law one must know the language of the law. And so the illustrations could be multiplied indefinitely. Where can one go to live a life of understanding and usefulness where it is not advantageous to know the language of law? Surely the planners of educational programs must provide for subjects that will teach the language of law. Two thousand years ago this language was written out

in the form of words spelled in full just as it might be spoken or written by two intelligent persons in conversation or correspondence using the language of the man in the street. But science and understanding and mastery of law made small progress under such a system. After long experience a new language of science and law was invented which makes use of signs and symbols and employs definite laws for their combination, manipulation and interpretation. After this invention, science, both pure and applied, advanced by giant strides to be the servant of man which it is today. It is this new language of law which has become so important in modern life. To an increasing number of people this language is the Sesame that opens the gates to life of beauty and significance. Let the planners of educational programs take full account of the need for learning this language. The writer makes no suggestions as to what subject teaches this language of law. It will not be difficult for anyone to find what subject it is.

Poor Old Robinson Crusoe! Life was tough for him. But how much harder it would have been if he had had to contest and compete with other men, handicapped as he was by lack of any kind of tools and implements. And how hard it is for people living in the world today handicapped by lack of such tools! And the tools are not all made of metal and plastics, they are not all operated by gasoline and steam. They are in large part and increasingly tools of the mind and habit. It is cruel beyond measure to send young people out into this modern world inadequately equipped with tools of intellect and skill. There must be tools to permit them to take an active part in cultural life, in social life, in business life, in economic life, in industrial life. No one subject in the school curriculum can supply all the needed tools. Each should be justified in part according to its usefulness as a tool. The ability to think quantitatively is a tool of wide usefulness. The ability to count, to compute, to interpret the calculations and data submitted by others is a tool of great necessity. The ability to apply old laws to new situations in a definite and scientific manner is a tool that many find useful. And those subjects that supply these tools should be encouraged. Let the planners of educational programs find what these subjects are and emphasize them.

There are people who think life is a game of chance. You do something, and if Fortune favors you, you succeed and reap the rewards of success; if you do not succeed the easy explanation is

that Fortune was against you. But in this day more and more people are aware of the fact that chance has little to do with results. We live in an orderly world where results are predictable if factors are controllable. Most of us understand this quite early in life and are interested in learning to adjust to orderly experiences. One person may call it logic, if it deals with thinking chiefly; another may call it organization if it deals with business or industry primarily. But by whatever name it is called, in whatever set of circumstances it functions, we all recognize its very great value in the kind of world we inhabit. It is something to train for, to think about, to sacrifice for, to build upon. And it is something to receive serious consideration in planning a course of studies for young people. What are the subjects that give experience with orderly thinking, orderly procedure of activity, systematic processes of work, with predictable results, with consistent outcomes? What are the subjects that give school experience in thinking and doing that are harmonious with later experience in organization and system and predictable ourcomes? Latin? I think so. Laboratory science? Almost certainly so. Public speaking? Properly presented it can contribute to these ends. Mathematics? Here you and I must maintain our neutrality, our disinterestedness and leave judgment to those in charge of the educational organization.

It is the right of those being educated to have intimate experience with those subjects which live eternally, which extend infinitely over all the universe, which touch life at all points, which may change and grow and expand but which never die. Such a subject as can endure neglect but does not thereby suffer; such a subject as can encounter opposition but does not thereby weaken; such a subject as can meet ridicule but does not from this experience take on corrosion; a subject whose neglect or ridicule handicaps those who slight it but retains its own strength and power to grow and triumph. Sometimes we hear of *dead* languages, or *dead* subjects; let us duly mourn their passing but spend no time trying to resurrect them. *Requiescat in pace.* Those subjects that have in them the power to live do not die. It is these subjects with which we should give our young people intimate experience. It is not so difficult to identify these subjects. If they help us to adjust intelligently to the experiences, spiritual and physical, that we cannot or ought not avoid in daily living; if they help us to attain power over the forces about us; if they give us the language of law; if they give us the

ability to live significantly; if they banish fear and give confidence, then they have the power to live, and it is the right of those being educated to have long and intimate experience with them.

It has long been insisted that one of the purposes of education is to prepare for the worthy use of leisure. I believe the young people being educated beat the educators to this conclusion by several centuries or millenniums, but however that may be, we seem now to be in agreement. And here is where the troublesome matter of individual differences presents its greatest problem, for in our leisure we all do what we want most to do, that is, *what we can do*. If we cannot do a thing we have no power to wish to do it, no matter how interesting it may be to those who can do it. Some people can drive very fast to nowhere in particular; some can over-eat and then spend hours in a semiconscious state digesting and getting up an appetite to eat again; some can only sit hours at a time and get vicarious thrills from moving pictures; some like music; some like reading; some like nature; some like literature; some get a great thrill out of doing dangerous things; some like to garden; some like mathematics. Some person wiser than the writer must decide which of these and numberless other activities constitute *worthy use of leisure*. There is a vast amount of good music, good literature, and good problems in mathematics that contain the best in amusement. But it is only available to those who have been taught enough to appreciate it. Let the planners of the educational program take into account that science and mathematics as well as literature and music will constitute the most worthy and most thrilling use of leisure for thousands of people if they know enough about these subjects to be able to appreciate their amusement or simple interest value.

It has often been said that mathematics is on the defensive. I do not think so. Teachers of mathematics may have allowed themselves to be maneuvered into a defensive attitude. But it can hardly be maintained that mathematics is on the defensive. Let us be a little more neutral, a little more *disinterested* (whatever that means); the subject we teach is in itself quite hardy and has the power to live. Judged on any rational basis it will justify itself in competition with any other subject in the curriculum, not only for the prospective mathematician, but also for the citizen who must earn his living in any capacity whatever and who wishes to live a complete life.

THE PREPARATION OF HIGH-SCHOOL SCIENCE TEACHERS

A PRELIMINARY REPORT OF THE COOPERATIVE COMMITTEE ON SCIENCE TEACHING

Editor's Note: The Cooperative Committee on Science Teaching is an organization created by five nationwide science societies to attempt the solution of important teaching problems that have defied each of them individually. Each of these organizations has given much thought and energy to obtain better preparation of teachers for science subjects. Progress has been extremely slow and we are now in a war which is demanding more attention to all science. But it is not merely a war program—the world conflict has just emphasized a general fault. It is commonly agreed that the conditions mentioned in this report do not apply to the large schools. It is in the schools where one teacher must handle two, three, or four subjects that the difficulties exist.

The committee is composed of two members from each of five national organizations: K. Lark-Horovitz and Glen W. Warner representing the American Association of Physics Teachers, B. S. Hopkins and Martin V. McGill, the American Chemical Society, A. A. Bennett and Raleigh Schorling, the Mathematical Association of America, Oscar Riddle and Walter F. Loehwing, the Union of American Biological Societies, and G. P. Cahoon and Robert J. Havighurst,the National Association for Research in Science Teaching. Robert J. Havighurst, The University of Chicago, is chairman. Copies of this report may be obtained from him.

The preparation of teachers of science and mathematics for the small high schools of this land is generally inadequate. This fact has been pointed out by educators and by scientists many times, but improvement has been slow. The Cooperative Committee on Science Teaching believes that the scientific societies which it represents can help to solve the problem if they will unite to support a common program. Such a program, requiring agreement and cooperation among scientists and with educators, is presented in this report.

Admittedly, the preparation of high-school teachers is better than it was fifty or sixty years ago. The situation which existed in 1880 was described by Elmer E. Brown, former Chancellor of New York University, who wrote concerning his young manhood, "I taught in a school down in Illinois, which was struggling to be a high school, before I had finished my own normal school course; and after receiving my normal school diploma, I was for three years principal of a three-year high school, in which I taught from time to time some ten or twelve different subjects, ranging from chemistry and astronomy to rhetoric and Caesar."[1] Today requirements for teacher's licenses make

[1] Elmer Ellsworth Brown, "The Need of Better Preparation of Teachers for Secondary Schools," *Education*, XXXIV (December, 1913), 201–6.

far more extensive formal demands in number of years and quality of courses required. The teachers colleges are becoming better staffed and more critical in their standards. In the city schools previous satisfactory teaching experience and higher technical standards in subject-matter preparation are familiar requirements. Higher standards of remuneration and promotion and better conditions of tenure hold today, and systematic encouragement for further study and for the development of a professional spirit is often provided by school boards and state authorities. But, with all these improvements, the beginning teacher of science or mathematics is seldom adequately prepared for the kind of teaching he actually must do.

The Problem Is Located Primarily in the Small High School

The problem to which this Committee is especially devoted concerns primarily the small high school. Half of the high schools in the country have five teachers or less. Three-fourths of them have ten teachers or less. Yet the small school must offer courses in at least twelve subjects, and many of them offer fifteen to twenty subjects. Most new teachers commence their work in small high schools because the larger schools require teaching experience of candidates for positions. The beginning teacher in a small school nearly always must teach at least three different subjects, and often four or five.

The problems of teacher preparation in the large cities are different from the ones discussed in this report. The school system of a metropolis usually controls the training of most of its prospective teachers through setting up standards which must be met by local teacher-training institutions, provides assistantships and substitutes' positions to give the beginning teacher experience, and assigns the teacher only one or two subjects to teach. Thus the high degree of specialization usually required of science students in college is not out of line with the specialized teaching assignments in the large schools. This report will not be concerned with problems which are peculiar to the large school systems, and much of the report will not apply to the situation in large cities and in teacher-training institutions which serve large school systems only.

The Problem Is Twofold

The teacher in the small high school is usually prepared too narrowly by his college for the variety of subjects that a teacher

in a small school must teach. The state certification authorities permit this because they do not require even a reasonable minimum of specific preparation in each subject which the teacher teaches. From this it develops that the problem has two related aspects. Both the college and the state certification authority must move, and move together, to meet the problem.

The certification or licensing board is almost helpless if it works alone on the problem. More and more the colleges have been adopting standards of concentration in a major department which make it difficult and often impossible for an undergraduate to secure a good preparation for teaching in as many as three science fields. As a reaction from the insufferable rigidity (from the point of view of the principal of the small high school) of a one-subject teacher, it is but natural to go to the other extreme, befitting a frontier society, of expecting each teacher to be ready and willing to teach anything. In order to secure a supply of teachers for the small schools, the certification authority sets the requirements for a license to teach a given subject at a very low level. The young teacher, being licensed to teach a variety of subjects, though not adequately prepared in them, is naturally assigned classes with little regard to his special abilities and personal preferences.

In order to improve this situation in science and mathematics[2] the colleges must provide opportunity for a "concentration" which shall lie not in one department but shall spread (not too thinly) over at least three subjects among the sciences and mathematics. The liberal arts degree should be granted for such a program of study. When the colleges provide a reasonably broad preparation in the sciences for the beginning teacher in a small high school, the certification authorities will be in a position to raise the standards for teachers' licenses.

After these changes are made, the colleges and the state departments of education will have to make the teacher-training and the certification programs effective by cooperating in the techniques of selecting teachers and in the improvement of the high-school science curriculum.

The College Preparation of High-School Science Teachers

The typical chemistry major in the typical college will take

[2] This report uses the term "science" to include mathematics. Sometimes, to be more explicit, the term "science and mathematics" is used.

about thirty semester hours in chemistry or one-fourth of his four years' work. As supporting courses he will take eight or ten hours in physics and about the same amount of mathematics. He may take three or four hours of a biological or an earth science. If, upon graduation, he goes out to teach in a small high school, he will find that he has but one chemistry class and that he must teach four other classes. If the high-school principal works things out carefully, the new teacher may find himself with classes in chemistry, physics, mathematics, and general science. More probably, he will have at least one class in biology, or history, or some other subject for which his college preparation has been negligible.

Another student, having been advised of the desirability of being "versatile" when he comes to look for a teaching job, may cut his chemistry preparation to the bare minimum that is required for a major, often twenty semester hours, and then may take a host of elementary courses in other science and nonscience departments. He will then be in a position to meet minimum requirements for almost any teaching job that comes to his attention because he has had a college course in practically every subject of the high-school curriculum.

Neither of these students is fairly prepared for his work as a high-school teacher. The first student has given more of his time to chemistry than is justified by his assignment to one chemistry class. Actually, he is now no more a chemistry teacher than he is a physics, or mathematics, or biology teacher. It would have been better if he had reduced his chemistry program and spent more time in the other science fields. The second student has whittled his chemistry down to the minimum, but he has used the time thus gained to get a smattering of a variety of unrelated subjects, which will hardly make him a good teacher of these subjects although it may give him a better chance to get a job when teaching jobs are scarce.

Neither of these students is as well prepared to get a job in a high school and to teach effectively as he might be if the college faculty had given thought to his program and had made provision for him to take a science-teaching major which would give him reasonably adequate preparation in three or four of the high-school subjects.

The College Can Do Something About It

A number of colleges have made special provision for a

science-teaching major. These colleges generally offer the student an opportunity to select his program from two or more related departments. For example, he may prepare for teaching in the physical sciences, or the biological sciences, or general science, or mathematics and physics.

The Committee recently sent a questionnaire to two hundred colleges which represented a fair sampling of the various types of higher institutions in the various parts of the country. All institutions which were known to be interested in the problem of preparation of high-school teachers were included together with a number of colleges chosen to secure a good sampling. Returns were received from slightly over half of the colleges to whom the questionnaire was sent.

Of these hundred institutions, 31 have set up programs for preparation of science teachers which differ from the usual program of a departmental major with related courses in other departments. In practically every case, the program has resulted from cooperation among the science departments. In many cases, the science departments called in the education department for information on the actual teaching assignments which their graduates may expect.

From the returns on the questionnaire, it appears that universities and teachers colleges are making more adaptations of their regular departmental programs to provide for the preparation of high-school science teachers than are the liberal arts colleges. Seventeen out of 33 universities reported special programs for science teachers, 8 out of 21 teachers colleges, and 6 out of 45 liberal arts colleges. Although the liberal arts colleges do not seem to pay much attention to the preparation of high-school teachers, many of their graduates actually go into high-school teaching. Studies made in the Middle West indicate that approximately half of the high-school teachers are prepared in liberal arts colleges. (Undoubtedly the proportion is much smaller in the East.)

The Committee is convinced that progress will be made in the preparation of science teachers only if the colleges consider that this preparation is of a professional nature and treat it as such. There should be a section in the college catalogue describing the program for the preparation of science teachers. This program should be worked out cooperatively by the science departments and the department of education. Such collaboration will result in a better solution of the problems of practice teach-

ing and the courses in methods of teaching, which the Committee recognizes as an essential part of the preparation of a teacher. In some states there is a five-year requirement for teacher preparation which permits a much better program. In the majority of states, where the four-year program is the normal preparation, colleges might require ten or fifteen semester hours beyond the minimum of 120 for the B.A. degree, as is done in professional engineering and agriculture curricula. However, the Committee believes that in most institutions a more satisfactory program can be worked out within the 120 semester hours usually required for the B.A. degree.

Preparation in Several Subjects Is Necessary

The Committee favors a program which gives the prospective teacher a fair preparation in at least three sciences. Any combination of three of the following five subjects is recommended: biological science (including both botany and zoology), chemistry, earth science, mathematics, physics. In practice the most frequent combinations of teaching assignments are the following: physics-chemistry-mathematics, physics-chemistry-biology, chemistry-biology-mathematics, and combinations of junior high school general science with any two or three of these subjects.

The Committee recommends that approximately one-half of the prospective teacher's four-year college program be devoted to courses in the sciences. Sixty semester hours, divided among three sciences, will allow for a 24-hour major in one subject and 18 hours in each of two others.*

This is the heart of the Committee's recommendation—that half of the college program be devoted to work in three science subjects. Such a program allows for a reasonable degree of specialization and insures enough breadth to prepare the student reasonably well for the teaching assignments he may expect during his first years of teaching. This program leaves ample room for the usual "general education" requirements of the college and for the required professional courses in education. For the student who plans carefully and is given advice early enough, it even leaves room for 18 or 20 semester hours of a subject such as history or foreign language or music which a

* When biology is one of the three subjects, the Committee recommends a minimum of 24 hours, because preparation in botany, zoology, and physiology is necessary.

student may wish to take as an extra subject to be added to his teaching repertoire.

One objection which may be raised against a comprehensive teaching major in the sciences is that it does not carry a student far enough in a particular subject to enable him to do graduate work in that subject. This objection can be answered by a requirement of 21 to 24 hours in at least one subject, which is enough to permit a student to go ahead with graduate study in a good graduate school, especially since it is supported by strong programs in two related sciences.

Further Experimentation Is Desirable

The Committee's recommendations are conservative. Many colleges already have programs of this sort, and others are adopting them. This kind of program will "work." Students who follow it will get jobs and be satisfied with their preparation for these jobs. But this report is not the last word.

Already there are interesting and important new experiments in the preparation of high-school science teachers which include unorthodox science courses dealing with such topics as the human life-cycle, the soil conservation problems of the Great Plains, and the geophysical and astronomical evolution of the world—topics which probably would figure in a more important way in the secondary-school curriculum if teachers knew more about them.[3] The prospective science teacher should have more experience in work involving the social and historical implications of science, such as may be gained through assisting in college science courses of the "cultural" type, through seminars for junior and senior students, and through reading and honors work. Also, experimentation is to be desired which aims to correlate and integrate the sciences, looking toward preparation of teachers for courses in physical science in the high school.

While this report is confined to recommendations for a better basic preparation in the sciences, the Committee is fully aware of the importance of improvement in other aspects of the teacher's preparation. The Committee agrees with those who are concerned about the development of the teacher as a person. Better use can certainly be made of the four or five years which is available. Whether or not a teacher of science or of any other subject ties in effectively with the total work of a

[3] National Committee on Science Teaching, *The Education of the Science Teacher*. Washington: National Education Association, 1942.

school probably depends far less on the number of hours of work he does in pedagogy than it does on the quality of such courses. In like manner the maturity with which the beginning teacher assumes responsibility for such community tasks as may reasonably be expected of a beginning teacher, and the intelligence which he shows in discussing the social problems that concern alert citizens, will depend far less on the number of courses in social studies than on the quality of such courses, and these unfortunately are far too often designed for majors in social studies with little attention to the needs of teachers in other fields. Experience with the arts and crafts also is desirable for the science teacher, but here, too, mere increase in the election of the ordinary existing courses is hardly likely to be useful. The construction and selection of the right kind of courses in the social studies, humanities, and professional education are problems of the utmost importance which this Committee recognizes as the province and the responsibility of its colleagues in those fields.

The Certification of High-School Science Teachers

The Committee knows that in commenting on the certification of high-school teachers it is dealing with a problem that is complicated by many difficulties of practical school administration in small schools. For this reason the Committee has proceeded cautiously, following the lead of educationists and scientists who have already worked on this problem.

Certification Standards Are Very Low

Licensing or certification for teaching in public high schools is a state function, usually performed by the State Department of Education. In some states the requirement for a license is limited to a certain number of semester hours in professional education courses, and the teaching certificate is a "blanket" certificate allowing the holder to teach any subject which he and the principal believe he can teach. Some states give a general teacher's license based on preparation in professional education courses, together with licenses to teach individual subjects which are granted on the basis of a given number of semester hours' work in each subject. A teacher may secure as many of these individual certificates as he wishes, by supplementing his undergraduate work with attendance at summer school and graduate work. Recommendations have recently been made for

certification in broad subject areas, such as science, social studies, foreign languages, and we may expect to see experiments in that direction. The Committee's proposal is an approach to the broad area plan—it calls for certification in at least three related subjects but allows for a number of combinations of three subjects within the area of science and mathematics. It also limits the number of nonscience subjects for which a science teacher may be certified.

At present, where certification is practiced with respect to specific high-school subjects, the requirement for a certificate is often as low as five semester hours of college work in a subject. This is not defended as good practice but as necessity, especially in small high schools which do not have enough teachers to permit assigning a full load to each teacher in his subject of special preparation.

The sciences of physics, chemistry, and biology, since they are usually offered in but one class in a small school, come off very poorly in terms of certification requirements. For example, the North Central Association of Colleges and Secondary Schools, which sets relatively high standards in the twenty states of its territory, considers "science" as a single subject field and requires the same number of hours' preparation, namely, fifteen, in science that it requires in English, history, or mathematics. Thus a teacher may be certified to teach "science" with fifteen hours distributed among the various sciences and need have only five hours of any particular science which he teaches, such as chemistry, or biology, or physics. At the same time, a teacher of mathematics must have fifteen hours of mathematics in order to be certified.

The Problem Lies in the Small High School

There have been many studies of the actual teaching assignments of teachers in small high schools.[4] In the small high school which offers a full college preparatory course together with commercial work, agriculture, home economics, music, and art, it is necessary to assign teachers classes in several subjects, sometimes quite unrelated. Many teachers teach three or more subjects, and the beginning teacher usually has the least desirable combination of subjects to teach. Potthoff[5] found 543

[4] For bibliography on this subject, see Edward F. Potthoff, *Simplifying the Combinations of Subjects Assigned to High School Teachers*, University of Illinois Bulletin, Vol. XXXVI, No. 87. Urbana, Illinois: University of Illinois, 1939.

[5] *Ibid.*

different teaching combinations in 400 Illinois high schools with ten teachers or less. While a large number of teaching combinations are necessary in small high schools, there is reason to believe that the number could be reduced materially if school administrators would attempt the task. Potthoff studied the 543 actual combinations in the 400 Illinois high schools and then devised a new scheme of 104 combinations which was workable "on paper" in these schools. Evans[6] made a study of teacher assignment practices in secondary schools of the North Central Association. Of the science teachers, 53 per cent were teaching two subject fields, 17 per cent were teaching three subject fields, and 2 per cent four or more. A "subject field" is a group of related subjects. Science as a subject field includes physics, chemistry, biology, earth science, and general science, but not mathematics, which is a separate field. Thus a science teacher teaching two fields might be teaching classes in three or four different subjects. This contrasts, for instance, with agriculture, where 71 per cent were teaching only one subject. Evans also studied the amount of preparation obtained by the teachers and came to the conclusion that school principals and superintendents do not always utilize their teachers as effectively as they might in view of their subject-matter preparation.

To sum up, the chaotic conditions with respect to teaching combinations are responsible for much poor teaching, since they make it nearly impossible for prospective teachers to anticipate their teaching assignments and prepare for them thoroughly. Furthermore, a premium is placed upon smattering rather than thoroughness in undergraduate teacher training because the candidate with a slight preparation in a great many subjects has a better chance of fitting more different combinations and therefore has a better chance of securing a position.

Possible Solution through Certification

A committee on teacher certification has been established by the North Central Association to study these problems. A similar committee has been active for some time in the Southern Association of Colleges and Secondary Schools. Both of these committees have been working toward a plan for reciprocity between states in the matter of certification of teachers. Such reciprocity will require a greater uniformity of certification procedures from one state to another.

[6] Ralph F. Evans, "A Study of Teacher Assignment Practices in Secondary Schools of the North Central Association," *North Central Association Quarterly*, XVI (January, 1942), 271–91.

The North Central Association committee[7] has considered the following proposals: that teachers' certificates should be issued for a limited number of years only; that certificates should be for teaching in broad, related areas; and that the procedures of re-certification should encourage continuous growth of teachers and seek to provide rewards for constant teaching.

The Cooperative Committee on Science Teaching favors a modification of the principle of certification in broad areas as it relates to the science area. This modification consists of certification in groups of three related subjects, such groups to be established on the basis of study of teacher-assignment needs and practices.

If a policy of this sort is recommended for certification of science teachers, certain additional factors must be kept in mind. A great many small high schools have vocational agriculture teachers and vocational home economics teachers who are paid partially from federal funds. If there is not a full-time teaching program in agriculture or home economics, these teachers have to teach other courses, often science. For preparation in agriculture or home economics the prospective teacher takes a minimum of twelve to fourteen semester hours of chemistry and a greater amount of biological science. By supplementing this preparation, the teacher may prepare for teaching chemistry, biology, and general science. The certification policy must allow for this. Furthermore, a college student (man or woman) who majors in physical education will normally take enough biological science and hygiene to qualify for biology teaching with little or no extra work. Finally, it has been found that certificates limited to three subjects will not always meet the needs of a small high school. If a teacher can teach a fourth subject, the program of the school is made much more flexible. A teacher prepared in subjects which are taught to only one class, such as physics or chemistry in a small school, is especially needful of certification in a fourth subject. For science teachers the fourth subject may well be general science, which requires added preparation in astronomy and geology and makes use of the sciences in which the teacher is already prepared. Physical education, or industrial arts, or home economics may often be prepared for with a minimum of extra effort by a science teacher. If is often useful or convenient to have a fourth subject quite

[7] John R. Emens, "A Teacher Certification Study," *North Central Association Quarterly*, XVI (January, 1942), 268–70.

unrelated to the three for which one is primarily prepared. Music and speech are good examples. The certification policy should provide for all of these situations.

Certification in Three Sciences Recommended

The Committee recommends a policy of certification in closely related subjects within the broad area of the sciences and mathematics. Any combination of three of the following five subjects is recommended: biological science (including both botany and zoology), chemistry, earth science, mathematics, and physics. A combination of general science with any two or three of these subjects is also recommended.

For certification in three subjects the Committee recommends that a total of at least 60 semester hours' credit be required in this area, with at least 18 hours' credit in each subject for which the certificate is granted, except that 24 hours' credit should be the minimum for certification in biology, including courses in both botany and zoology.

The Committee proposes this policy as a minimum for beginning teachers. As the teacher gains experience and if he looks for a position in a larger school, he should be required to take further work in the subjects in which he plans to specialize.

Should a person wish to prepare to teach general science in the junior high school only, the Committee recommends as an alternative to the foregoing plan of certification in three subjects the requirement of a minimum of 15 hours in biological science, 15 hours in physical science (including both physics and chemistry), 6 hours in earth science, and 6 hours in astronomy. Teachers whose special preparation is in the physical sciences or mathematics should in any case take an introductory course in biology, because they will usually be called upon to teach general science.

The Committee also approves a policy of certification of science teachers in one subject unrelated to the field of science and of certification of teachers with major preparation in other areas for one or more sciences. In the case of a teacher with major preparation in some other field such as social sciences or foreign language, the Committee recommends that a minimum of 21 hours' work be required in physics, chemistry, or mathematics, 24 hours in biological science, and the requirements listed above be maintained for general science. The reason for this increase in the proposed minimum when a teacher prepares

for but one science subject is that he will lack the advantage of supporting courses in other sciences.

Does Informed Opinion Approve the Committee's Recommendations

The Committee has taken pains to find out the views of the various persons and groups that are interested in this problem. There appear to have been no attempts by organizations interested in all the sciences to propose specific certification procedures. The Committee on the Training of Science Teachers of the National Association for Research in Science Teaching[8] recommended a pattern of undergraduate training similar to that here recommended. Committees of scientists and educationists in various institutions, such as one at the University of Illinois[9] and one representing a number of higher institutions in Indiana, have made proposals for the undergraduate training of prospective teachers of science and mathematics in harmony with the policy recommended by this Committee.

The study made by Evans[10] in the North Central Association territory showed that an overwhelming majority of school principals agree that beginning teachers should and can be assigned much more nearly to fields for which they are best prepared. A study by Newburn[11] indicates that high-school principals believe that while teachers can meet present standards of certification, their real training is often too meager for effective instruction in certain subjects.

Summary

The Cooperative Committee on Science Teaching has concerned itself with the preparation in science and mathematics of prospective high-school teachers of these subjects. The Committee has attempted to suggest a program which would be adequate for the preparation of the beginning teacher, who usually must teach three or four subjects in a small high school. Reform of the type suggested by the Committee can come about only through action of college faculties and of state certification authorities.

[8] Preliminary Report of the Committee of the National Association for Research in Science Teaching on the Training of Science Teachers," *Science Education*, XXII (November, 1938), 283–93. See especially, p. 286.

[9] Potthoff, *loc. cit.*

[10] Evans, *loc. cit.*

[11] Harry K. Newburn, "The Preparation of Secondary School Teachers: II. Implementation of Reforms within the High School," *North Central Association Quarterly*, XIV (October, 1939), 188–93.

The Committee recommends that approximately one-half of the four-year college program be devoted to courses in three science subjects. Any combination of three of the following five subjects is recommended: biological science (including both botany and zoology), chemistry, earth science, mathematics, physics. Science departments in the colleges are urged to cooperate among themselves and with the department of education in devising such a program of teacher preparation.

At the same time, the Committee recommends a policy of certification or licensing of teachers for three subjects to correspond to the program which teacher-training institutions are asked to adopt. The Committee recommends that a total of at least 60 semester hours' credit be required in the science area, with at least 18 hours' credit in each subject for which the certificate is granted, except that 24 hours' credit should be the minimum for certification in biology, including courses in both botany and zoology. For certification to teach general science in the junior high school only, the Committee recommends as an alternative to certification in three subjects the requirement of a minimum of 15 hours in biological science, 15 hours in physical science (including both physics and chemistry), 6 hours in earth science, and 6 hours in astronomy.

Implementation of This Report

The practical results of this report will depend upon what is actually done in colleges and in state departments of education about the problems of preparation and certification of teachers. There are two ways by which scientists and educators can work to influence practices in colleges and state departments of education.

In colleges, members of the departments most interested in these problems can act on their own initiative to broaden the science preparation of prospective high-school teachers. Much progress has already been made by this method, as the answers to our questionnaire show. College science departments may also cooperate with departments of education to devise professional programs for the preparation of science teachers.

The best method of effecting changes in certification procedures is through organizing committees on state and local bases which can make their voices heard in the state capitol and the state university. This method has been effective since 1939 in the state of Indiana, where a statewide committee has

made proposals for certification which are being considered by the State Department of Education.[12] In Pennsylvania there is a Committee for the Promotion of Science in Secondary Education for the State of Pennsylvania. This Committee recently issued a report on certification of science teachers in secondary schools[13] which recommends raising the standards for certification in that state.

The Cooperative Commitee on Science Teaching stands ready to advise any state or local group which is interested in the problems treated in this report. Correspondence is solicited. Copies of this report may be obtained free of charge by writing to the Chairman of the Committee, at The University of Chicago.

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[12] K. Lark-Horovitz, *American Journal of Physics*, Fall, 1942.

[13] M. H. Trytten, "On the Certification of Science Teachers in Secondary Schools," *American Journal of Physics*, x (April, 1942), 122–23.

WAR-TIME CHEMICAL SHOW AND PARLEY

Regarded as an important contribution of the chemical industry to the war-time effort, the National Chemical Exposition will be held November-24 to 29 at the Hotel Sherman in Chicago.

Added importance will be given the show because of the conference to be held in conjunction to be addressed by leaders of the industry, educators and other authorities. The program is now being arranged by the conference committee.

Victor Conquest, who is chairman of the show committee, anticipates an attendance of approximately 20,000 from all sections of the country including research chemists, executives of industrial plants, engineers, purchasing agents, government specialists and others who will be afforded the opportunity of making valuable contacts at the show and conference.

NEED FOR SCIENTISTS REDUCES REQUIREMENTS

The Government's urgent need for scientifically trained men and women, particularly for physicists, metallurgists and chemists, has brought about a let-down in the requirements, the Civil Service Commission has announced.

College teaching, and in the case of physics, high school, preparatory school and trade school teaching, may now be offered as professional experience. There is no maximum age limit, no "recency" clause with respect to education or experience, no deadline set for applying for the positions. However, persons qualified are urged to apply at once. There is excellent opportunity for women physicists and chemists, the announcement stated.

The requirements now are, for the $2,600 grade, a four-year college course leading to a bachelor's degree, plus two years of professional experience. Additional experience is required for the higher grades.

UP-TO-DATE FACTS ABOUT FOODS

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[EDITOR'S NOTE. Health education is now recognized as one of the most important phases of elementary and secondary school curricula, not only as a part of the science courses, but as an integral part of the whole school program. In this article Miss Fruit gives the up-to-date facts about food and diet for children and adults. Educators now consider it highly important to have a practical knowledge of foods and diet for their own benefit as well as for the benefit of the young people under their supervision. The author will be glad to answer any additional questions about food and diet by correspondence. Inclose a self-addressed stamped envelope with your letter.]

The United States has been a land of surplus food commodities yet we are told that more than 40 per cent of the people are undernourished and consequently in low mental and physical health with little resistance to disease. At a National Nutrition Conference called by President Roosevelt in May, 1941, it was pointed out that our nutritional problems today are concerned with a need for "(1) wider and better distribution of food and (2) proper utilization of foods in well proportioned and well prepared diets."[1] In the latter, the schools must take an active responsibility in teaching nutrition and health education.

Food is only one of the many things needing emphasis in such a program but it is one of great importance. A study of the chemical composition of the body shows it to be made up of 65 per cent water and 35 per cent solids of which 88.18 per cent are carbohydrate, protein and fat and 11.82 per cent are minerals.[2] These elements must be furnished by the food children eat and the water they drink in quantities sufficient for growth of bones, teeth, muscle, and blood, for health and daily activity.

A. PROTEINS

Recent studies on proteins as well as fats, carbohydrates and minerals have changed our knowledge of them very little compared with the studies of vitamins. Protein is the chief constituent of body fluids and makes up most of the weight of the muscles and organs. Since protein cannot be stored in the body for future use, even when an excess is eaten, it is important to have it included in the daily diet. If one eats too little energy

[1] Hirsh, Joseph, *Food For Thought*, Education and National Defense Series Pamphlet No. 22, U. S. Government Printing Office, Washington, D. C., 1941, pp. 1–3.

[2] Jean J. Stewart, *Foods Production, Marketing Consumption*, Prentice-Hall, Inc., New York, 1938, p. 538.

food, protein is used for energy rather than building body tissue.[3]

Muscle meat of animals and fowls, and fish are doubtless the foods that come to mind first when protein is mentioned. They are protein, but there are other protein foods which are as valuable and sometimes more valuable because of the additional minerals and vitamins they carry. Milk, cheese, and eggs are in this group and should always be well represented in the day's dietary along with meat and fish. These are animal proteins, called "complete" because they supply elements sufficient to maintain life and build tissue. There is another group of proteins called "incomplete" which are valuable and inexpensive but need to be supplemented by a "complete" protein food to insure growth and tissue building. Plants such as peas, beans, lentils, and cereals, are generally the source of "incomplete" proteins. Exceptions to these general rules are peanuts, soybeans, and almonds; three plant foods which are recognized as furnishing "complete" or nearly complete protein. On the other hand gelatin, an animal protein, is "incomplete."[4]

B. Energy Foods

Fats are chiefly energy food which when eaten in sufficient amounts relieve the body of unnecessary protein oxidation. They also carry the fat soluble vitamins. Animal fats, butter, cream, eggs, bacon, and fish oil are considered of better food value than the vegetable fats such as olive, peanut, and corn oils because of their higher vitamin content.[5]

The most immediate source of energy is carbohydrates. Carbohydrate foods are sugar, starch, syrup, cereals, root vegetables, and the less watery fruits such as dates and bananas.

C. Minerals

Minerals, important as builders, regulators, and protectors, are found in varying amounts in the body. Those needing special consideration are calcium, phosphorus, iron, copper, and iodine. If the diet supplies the necessary amounts of these minerals, one can be relatively sure of getting the trace minerals.

Calcium and phosphorus, present in large amounts in the body, influence growth and are necessary in correct proportions

[3] Hawley and Maurer-Mast, *Fundamentals of Nutrition*, Charles C Thomas, Springfield, Illinois, 1940, p. 25.

[4] *Ibid.*, p. 25.

[5] *Op. cit.*, p. 27.

for building bones and teeth of the proper rigidity. They, with iron, are also essential constituents of the blood, muscle, and nerve tissue.[6] Calcium is necessary for the normal heart beat and coagulation of the blood. Most of the iron in the body is found in the blood and is the constituent which makes possible the exchange of oxygen and carbon dioxide in respiration. Copper is important in the utilization of iron. Iodine is necessary for normal functioning of the thyroid gland which influences growth.[7]

Some foods which are relatively high in calcium are: milk, cheese, egg yolk, potatoes, almonds, oranges, leafy vegetables, oatmeal, whole wheat, apples, beans, and filberts. Foods rich in phosphorus are: almonds, meat, milk, whole grains, cheese, egg yolk, chocolate, fish, lentils, peanuts, and potatoes. Foods especially rich in iron are: egg yolk, liver, oysters, parsley and molasses. Other good sources are: kidney, heart, whole grains, legumes, beef, leafy vegetables, prunes, raisins, and nuts. Foods rich in available iron will also furnish copper. The most reliable food sources of iodine are sea foods and iodized salt. Foods such as cranberries, when grown near the sea are comparatively good sources.[8]

The body being approximately two-thirds water indicates the importance of it as a building material and regulator of body processes. It is a part of cells and provides the liquid for the digestive juices and the blood. It is necessary in maintaining a normal body temperature and for elimination of waste through the lungs, skin, kidneys, and intestines. It also keeps the mucous membrane moist.

D. Vitamins

Of the many vitamins, "food factors essential for normal health,"[9] which have been identified, only those which are important in human nutrition are mentioned here.

Vitamin A has been called the anti-infective vitamin which is true only in that it builds up the body's resistance to bacterial invasion by keeping the mucous membranes in a healthy condition. It is necessary for growth, health, body vigor, appetite, reproduction, good vision, eye health, and the ability of eyes to adjust to light and dark.[10]

[6] Chaney and Ahlborn, *Nutrition*, Houghton Mifflin Company, Chicago, 1939, pp. 111 and 132.
[7] Wilmot and Batjer, *Food for the Family*, J. B. Lippincott Company, Chicago, 1938, pp. 22–25.
[8] *Op. cit.*, Hawley and Maurer-Mast, pp. 37–40.
[9] *Op. cit.*, Hawley and Maurer-Mast, p. 243.
[10] *Op. cit.*, Hawley and Maurer-Mast, p. 29.

The most reliable sources of vitamin A are: cod, halibut and shark[11] liver oils, milk and milk products, egg yolk, and green and yellow vegetables. Carotene, which is the yellow coloring in carrots and some other green and yellow vegetables, is absorbed from the digestive tract and converted into vitamin A by the liver. Liver and kidney may be good sources if the animal has had an excess of the vitamin in his diet to allow storing.[12] Alfalfa and grass are excellent sources and since they are valuable foods for cattle dairy products are good sources of vitamin A.[13] The green leaves and stalks of vegetables such as lettuce and celery are richer sources than the bleached.

Vitamin A, being fat soluble, there is little danger of its being lost in cooking water. It is stable to ordinary cooking temperatures but not to rancidity, which is the reason for keeping fish-liver oils in cold, dark places.[14]

Thiamine, vitamin B_1, is essential for growth, appetite, digestion, proper nerve function and health of all ages. It is necessary for completing the oxidative processes, especially of carbohydrates.

There should be no danger of a lack of thiamine in the diet because it is commonly found in all parts of plants. However, it does take careful planning to meet the daily requirement set up by the Committee on Food and Nutrition of the National Research Council. We need to emphasize thiamine rich foods, because we eat too much of those highly refined which definitely lack it. Good sources of thiamine are wheat germ, glandular meats, lean pork, whole grain cereals, nuts, milk, fruits, legumes, and green vegetables. Mature peas and lima beans contain less than the very young. Pork and chicken are better sources than beef. Dried fruits contain little thiamine as sulphur used in the drying process tends to destroy it.[15]

Thiamine is rather stable especially in acid and dry foods. Very little is destroyed at ordinary cooking temperatures but the rate of destruction gradually increases with an increased temperature, as in pressure cookers. It being water soluble the water in which vegetables and fruits are cooked or the liquid from a can will contain thiamine, so there is loss if it is discarded.[16]

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[11] Chase, Victoria, "Shark Bonanza," *Reader's Digest*, Volume 40, No. 238, pp. 66–68, February, 1942.
[12] *Op. cit.*, Hawley and Maurer-Mast, p. 29.
[13] Sherman, *Food and Health*, The Macmillan Company, New York, 1939, pp. 118–119.
[14] *Ibid.*, Chaney and Ahlborn, p. 170.
[15] *Op. cit.*, Chaney and Ahlborn, p. 214.
[16] *Op. cit.*, Chaney and Ahlborn, p. 210

Riboflavin, vitamin B_2, is also known as Vitamin G. It is considered important in human nutrition and though no specific human disease seems to result from a lack of it there are indications that a deficiency of riboflavin may be associated with cataract and pernicious anemia. It is essential for good health and growth and is now thought a necessary adjunct to vitamin A for relief of night blindness.[17]

Sources of riboflavin are milk, liver, kidney, heart, muscle meats, yeast, wheat germ, eggs, fruit, green vegetables, soy beans, and cotton seed meal. It is water soluble, stable to heat, cold, and acids but destroyed by soda, hard water, and light.[18]

Nicotinic acid, the "Pellagra Preventive" vitamin, is the major factor though probably not the only one in preventing pellagra. Pellagra is characterized by a sore mouth, skin eruptions on parts exposed to the air and sunlight, digestive and nervous disturbances. It has been common in the south among poor white and negro families where diets during winter months consist mainly of fat, salt pork, corn bread, grits and syrup. By adding milk, eggs, green vegetables, lean meat and fish the disease is prevented. Yeast, glandular meats and salmon are also good sources.[19] Nicotinic acid is soluble in water, destroyed by soda but not by heat.

Vitamin C, ascorbic acid, so essential for cell respiration, definitely prevents scurvy which is characterized by tenderness and swelling of the joints, spongy and bleeding gums, and loose teeth. It aids in the resistance to other diseases and in the healing of wounds. Vitamin C is very unstable. It is soluble in water and "readily changed by oxidation, heat and sunlight or by the presence of copper."[20] The best sources are citrous fruits, tomatoes (fresh or canned), fresh and uncooked fruits and vegetables and sprouted grains.[21] By using perfected methods commercial canners are able to conserve most of the vitamin C. "Canned orange juice is shown to be only slightly less rich in C than fresh."[22]

Vitamin D prevents rickets in infants and children and bone deterioration and infection in adults sometimes known as osteomalacia. Rickets may also be caused by a lack of calcium

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[17] *Op. cit.*, Hawley and Maurer-Mast pp. 30–31
[18] *Op. cit.*, Chaney and Ahlborn, pp. 220, 222.
[19] *Op. cit.*, Hawley and Maurer-Mast, p. 31.
[20] *Op. cit.*, Hawley and Maurer-Mast, pp. 32 and 270.
[21] *Op. cit.*, Hawley and Maurer-Mast, p. 32
[22] *Op. cit.*, Chaney and Ahlborn, p. 240.

and phosphorus and is characterized by deformed arms and legs, "pigeon breast," beaded ribs and enlarged abdomen. With a deformed chest breathing may be impaired and thus the individual is more susceptible to respiratory infections. It is "necessary for the bone and tooth development, general well being, and normal absorption and utilization of calcium and phosphorus."[23]

Vitamin D is very stable but becomes ineffective in rancid oil. It can be stored in the body but the diet of a child and the adult needs to be supplemented with it because the natural foods which supply it are so limited. The sources of vitamin D are cod and halibut liver oils, butter, egg yolk (especially when the hens are exposed to ultra violet light or fed irradiated food), salmon, whole milk ("irradiated" or "fortified"), irradiated yeasts and grains, and direct sunlight.[24] When the skin is directly exposed to ultraviolet rays of the sun or artificial light there is formation of vitamin D in the body. The sun is not too reliable a source as the potency of its rays varies with the altitude, time of day, thickness of skin, fog, clouds, dust and smoke in the air.

Vitamin K is necessary for normal blood clotting though there seems to be no relationship between it and hemophilia. It was first observed among chickens where a lack of it caused a hemorrhagic disease. It is found in hog liver oil, cabbage, spinach, tomatoes, soy bean oil, rice, bran, and alfalfa. It is also manufactured through bacterial action in the intestinal tract.[25]

E. Food Essentials

Most of the food value of vegetables is conserved when they are eaten raw. When vegetables are boiled in water, minerals and the water soluble vitamins dissolve out into the cooking water. Naturally there is great loss of food value unless this liquid is utilized in soups and gravies. There is also a loss of nutrients when vegetables stand in water to freshen before cooking or serving. The best way to conserve nutrients is to cook the vegetables quickly in a small amount of water which will be reabsorbed, or bake or steam them in their jackets. However the strong flavored vegetables are generally cooked in a large amount of water to improve their flavor and the green vegetables to preserve their color rather than nutrients. Soda should

[23] *Op. cit.*, Hawley and Maurer-Mast, p. 33.
[24] *Op. cit.*, Hawley and Maurer-Mast, p. 33.
[25] *Op. cit.*, Hawley and Maurer-Mast, pp. 34 and 282.

never be used in cooking vegetables as it destroys the water soluble vitamins.

Children and adults will get all of the food essentials, with the exception of vitamin D, if they are eating a well balanced diet of natural foods. The adequateness of one's diet may be easily determined by use of the check list found on page 15 of Folder No. 14 "Well-Nourished Children," Children's Bureau, United States Department of Labor.

A Daily Check List

Milk.—One and one-half pints to one quart a day for each child.
Butter (or oleomargarine that contains added vitamin A).—At every meal.
Fruits and Vegetables.—At least four servings a day for each child. In choosing them, consult this list:
A fruit or vegetable rich in vitamin C: oranges, grapefruit, tomatoes, green leafy vegetables, cabbage, turnips.
A vegetable or fruit rich in vitamin A and in iron: green leafy vegetables, other green vegetables, yellow vegetables, yellow fruits, ripe tomatoes.
Potatoes: At least one serving a day.
Another serving of some kind of fruit or vegetable every day.
Eggs.—One a day for each child if possible; at least four or five eggs a week for each young child.
Meat or Fish.—Once a day, or at least four times a week.
Cereals and Bread.—One serving of cereal a day for each child; bread according to appetite and energy needs; perhaps at every meal.
Sweets.—For dessert, if appetite allows, after the other foods listed have been eaten.
Cod Liver Oil.—Every day.

Anyone of these groups of foods make interesting and valuable detailed study for children. A series of lessons on cereals might include kinds, planting, cultivating, structure of grain, difference between refined and whole grain and between ready prepared and cooked cereals. The final lesson of preparing and eating a cereal in class would be very important. The cereal should be cooked and seasoned to perfection and the lesson come at a time of day when appetites are at their peak.

The school cannot make much headway in improving the nutritional status of our children unless there is a carry-over in the home. Such cooperation may be obtained through giving the children home projects and through nutrition classes for mothers which may be taught by agencies outside of the school.

F. Additional Helpful References

Sense, Eleanora, *America's Nutrition Primer*, M. Barrows and Company, New York, 1941.

Roberts, Lydia J., *Nutrition Work With Children*, University of Chicago Press, Chicago, 1935.

Rose, M. S., *Teaching Nutrition to Boys and Girls*, the Macmillan Company, New York, 1932.

Nutrition Education Through The School. Reprint, *School Life*, Washington, D. C., U. S. Office of Education, Federal Security Agency 1941.

Leaflet No. 42. *Good Food Habits for Children*. U. S. Department of Agriculture, Bureau of Home Economics, Washington, D. C.

Valuable educational material may also be obtained from, The National Dairy Council, 111 N. Canal, Chicago, or the Milk Foundation Inc. 75 E. Wacker Dr. Chicago.

GUIDANCE AND THE SCIENCE TEACHER

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The science teacher may be very helpful in both educational and vocational guidance of the pupils under his direction. The modern concept of guidance is that the classroom teacher is the crux of any guidance program. The teacher should be on the alert to watch for special aptitudes on the part of each and every pupil so that these aptitudes may be discovered and developed to their fullest extent. The frequently made statement that there is a spark of genius in every child has its limitations because we know that this is not actually true. We do know that there are certain special abilities which pupils possess, but they do not possess them to the extent which we consider on the level of genius. Nearly all pupils who are capable of executing the activities required in the present secondary school, if they have an I.Q. of 80 or above, have a special ability which is adequate for ordinary competition in whatever field it may be. This means that every child, if his special ability is discovered, will be able to earn an adequate living in the area in which he has ability.

GUIDANCE IN THE SCIENCE CLASSROOM

The science teacher has an exceptional opportunity to observe the pupils in all phases of ability; namely, the intellectual, artistic, manual, mechanical, social, and creative. In providing a variety of activities which are possible during the assimilation period in a unit in any one of the sciences, the teacher can watch for special abilities which may be indicated. If such special abilities are observed, the teacher should make recommendations to the child so that he may modify his program if possible, and especially encourage a child in the special ability so that he may secure enough enthusiasm and momentum to continue in its

development. Many persons who have achieved outstanding success in specialized fields can relate an incident where some kind and understanding teacher encouraged them to go on with study in this area.

During the assimilation period of a well guided unit in any secondary school science subject, pupils have an opportunity to explore and develop their abilities in elementary library research, skill in experimentation, drawing of the plane and perspective type, freehand drawing, color sense, leadership, oral and written expression, mechanical aptitude, finger dexterity, social adaption, and many others. This may be accomplished by providing for enriched pupil purposing experiences such as free reading, committee and individual projects pursued in and out of school, and pupil oral and written reports pertinent to the problem or unit approved for class study.

In order for a science teacher to effectively execute this guiding phase, all science subjects in the secondary school should be taught with the idea of exploration. At the present time, it is a rare happening that a child is able to secure a position in the science field immediately after leaving high school. With this fact in view, it is evident that a high school's main objective is, not to prepare chemists, biologists, and physicists, but to give pupils a background with which they may interpret their environment, secure better living, and reveal to them the possibilities of future study in these areas of science.

In connection with the teaching of the science subjects, pupils should be encouraged to study and report upon the life histories of famous scientists. These biographies may reveal to the pupils the training necessary and the experience and abilities required for success in the science fields. Along with this, the pupils should be encouraged to read and study about different scientific professions, such as medicine, all types of engineering, medical technology, and nursing.

Science Clubs and Guidance

The science teacher has unlimited possibilities in effecting educational and vocational guidance through the activities of science clubs. In order to secure the maximum amount of guidance, especially in the larger schools, the activities for each club should be comparatively narrow in scope. Science clubs are functional in the junior high school, but in the senior high schools specialized clubs are preferable and should be primarily

confined to activities related to chemistry, radio, physics, biology, or health, and may be named accordingly.

The guidance objective in these club activities may be achieved through (1) activities within the school, and (2) field trips. At the regular club meetings, members may do advanced experimentation, reading, and conduct discussions which have to do with occupations and professions requiring a scientific background. During field trips, the members are given the opportunity of seeing the chemist, engineer, medical technician, x-ray technician, and laboratory worker actually at work.

Pupils in cities of 20,000 or more have the advantage of these first-hand observations in their own community where field trips can be conducted during school time or after school without interference with regular routines. Schools in smaller communities, however, have these facilities within a maximum radius of 75 miles. With present transportation facilities, such distances are not a handicap. During a single day, from three to five establishments may be visited and outstanding educational and vocational guidance values achieved. Missing a day of school for such purposes has no more objectionable features than losses due to the activities of interscholastic athletics.

The city health department, a modern clinic, and a hospital with its modern medical and x-ray laboratories provide excellent guidance opportunities for prospective medical technicians, nurses, and students of medicine and medical research. Any factory, foundry, brewery, sewage disposal plant which is of sufficient size to maintain a full time chemist and laboratory can make the responsibilities of the engineer, chemist, and so on more real to the inquiring pupil.

The science teacher has a greater opportunity than any other subject teacher in the secondary school to give functional educational and vocational guidance. A teacher is not fulfilling his mission if these opportunities are neglected.

FLUORESCENT LAMPS

Flickering fluorescent lamps will no longer be the annoyance they have been if the lamp is provided with a new type of starter now available which cuts the flickering lamp out of the circuit. At that moment a red button on top of the starter snaps forward, and must be pushed back to reset the starter after the worn-out lamp has been removed from the fixture. This can be done without turning off the current.

NOTES FROM A MATHEMATICS CLASSROOM

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(*Continued from the June issue*)

22. Improving the Course in Geometry. Two previous articles have discussed (1) how the critical thinking which geometry aims to develop can be applied to life situations, and (2) how time can be provided for this extra material by a wise selection of fundamental theorems. (See SCHOOL SCIENCE AND MATHEMATICS, March 1939, and May 1941.) Time can also be saved by a wise selection of the exercises. Time is often wasted on trivial exercises and by methods which emphasize details rather than the broader general principles.

23. Too Many Sub-divisions. At the request of some teachers I once compiled a great many exercises based on proving triangles congruent. Several hundred exercises were divided into groups as follows:

(1) The three equations that proved the triangles congruent were stated explicitly in the data, such as $AB=DE$, $\angle A=\angle D$, $AC=DF$. This group could itself be divided into three subgroups based on *sas*, *asa*, and *sss*.

(2) Two of the equations were explicitly stated in the data and the pupil must supply the third by using vertical angles, complements or supplements of equal angles, or see that certain angles were right angles.

(3) One equation was in the data and the pupil must find the other two equations by using vertical angles, right angles, etc.

(4) Using the data the pupil must add or subtract some equal lines from some other equal lines, or angles from angles, etc.

(5) From some triangles which the pupils must prove congruent some corresponding equal parts could be found that could be used to prove another pair of triangles congruent. This group could be divided into subgroups in various ways.

Enough has been said to illustrate the possibilities. By this detailed study the teachers hoped that thereafter the pupils would know how to prove triangles congruent. The class in pedagogy can find many reasons for justifying this process, such as (a) the pupil learns to study the data and to deduce new relations from the given ones, and (2) slow pupils must have every process broken into very small steps with much drill on each step.

But consider the matter from the following point of view. Imagine two pupils, A and B, who are confronted a month later with a problem of proving two triangles congruent. One of the pupils, A, has received so much preliminary drill on every possible method that the correct method immediately occurs to him and he can write the solution at once. (How we do like such pupils!) The other pupil, B, has not received this thorough drill but he knows that there exist three methods, at least one of which ought to work. He tries method 1 but sees he must discard it for some reason; then he tries method 2, weighing and discarding various ideas until he finds the right method. I believe that pupil B is getting a better training than pupil A even though B may work fewer exercises. If the teacher drills too much on all the possibilities that may arise, the teacher is depriving the pupil later of an opportunity to analyze, test, discard, analyze, test, discard, and so forth. Of course both pupils must be given some preliminary acquaintance with the methods. Thirty years ago pupils were thrown too much on their own resources; now, like a pendulum that has swung to the other end of its arc, pupils are given too much help. Instead of using geometry as means to develop certain habits we are regarding the solution of exercises as the only objective of the course. Geometry is both a means and an end; and the desirable habits can be acquired from significant exercises as well as from trivial ones.

24. Teaching the Axioms in Geometry. Time can also be wasted by basing too many exercises on the axioms. I doubt whether a pupil needs to understand each axiom at the first reading. I would have the pupils read them once and if John asked what axiom 7 meant my answer would be, "After we have tried a few exercises I shall explain it if necessary." Suppose we then have an exercise in which points A, B, C, and D are on a line and the question is, "If $AB=CD$ why does $AC=BD$?" John's answer might well be, "If $AB=CD$ and if you add BC to each part, then $AC=BD$." If pressed for more detail he might say, "Well, if $AB=CD$ and you add BC to AB and to CD, then $AC=BD$ because $AB=CD$." Then we ask "What general idea about lines are you unconsciously using?" If John does not grasp this hint we can ask, "Which of the general statements called axioms are you using although you are not mentioning it in your explanation? Perhaps you think it is too obvious or too trivial to be worthy of mention."

This practice of finding a general statement that will support

an argument is good training and a preparation for finding the hidden assumptions on which many arguments are based. If much time has been spent on explaining the axioms at the start, John would have recognized the correct axiom at once. If the axioms have not been explained in great detail John will be forced to test, discard, analyze, test, discard, analyze until he finds the correct axiom.

What has been said about congruent triangles and axioms applies to many topics. There are four common ways of testing quadrilaterals to see if they are parallelograms. The four ways may well be mentioned, read, stated, perhaps proved in a single session, and the pupil then given some practice in finding which method will work in some exercises. This is better training than proving one of the theorems, working an exercise based on that theorem, proving another theorem, working an exercise based on that theorem, proving another theorem, and so forth. If, some weeks later, the pupils have forgotten the four methods we have an appropriate setting for doing some review work and there will be a motive for learning those methods.

25. Significant Exercises. Textbooks get bigger and bigger every year. I wonder how inexperienced teachers select the few hundred that a class can be expected to work in a year. After considering the usual introductory exercises, my preference is for exercises that (a) are stated in a general language or can be generalized by the pupil if stated for a specific figure, (b) can be solved in more than one way, (c) have application to some field of science, and (d) involve some important bit of detail that many pupils will overlook. Few exercises will meet all these criteria but a good exercise will satisfy at least two of the four. A valuable Master's Thesis could be written on Criteria for Selecting Exercises. We have had theses on the best exercises in algebra; we could profit by a similar one in geometry.

By criterion (a) I mean an exercise like:

In the quadrilateral $ABCD$, $AB=CD$ and $BC=AD$. Are the opposite sides of the quadrilateral parallel?

This exercise can be studied as soon as the class has learned to prove lines parallel. Since the pupil at this stage will not be familiar with the word parallelogram, his generalization of the exercise will be:

If a quadrilateral has its opposite sides equal, the opposite sides will be parallel.

In this way the pupil can be prepared for all the theorems that

he will meet later except those that are proved in some unusual manner such as the one about the ratio of the areas of similar polygons.

As an example of criterion (c), consider:

A soldier wishes to walk from point A to a point X on the bank of a river to fill his canteen and then walk to a point C on the same side of the river as A. Find the point X so that his path from A to X to C will be the shortest.

The only theorem on inequalities in this exercise is that a side of a triangle is less than the sum of the other two. This exercise is valuable as an introduction to many similar ones that lead to a discussion of the angles of incidence and refraction of light, a study of images and mirrors, and the path of a billiard ball after striking a cushion.

As an example of criterion (d), consider:

Through a point B on the bisector of angle A, lines are drawn parallel to the sides of the angle intersecting the sides of the angle at C and D. Is $ACBD$ a rhombus?

The careless pupil will say that triangles ACB and ADB are congruent (since AB is a diagonal of a parallelogram), and so $AC=AD$ (corresponding parts . . .). And $AC=DB$ since the opposite sides of a parallelogram are equal. Hence $AD=DB$, which makes the figure a rhombus because two adjacent sides are equal. Here the pupil has forgotten that when proving triangles congruent we fix certain parts to correspond. Further, his proof does not use all the data; if his proof were correct we could reach the same conclusion after eliminating the unused item from the data, and so any parallelogram would be a rhombus. The exercise provides opportunity for many good questions.

Another example is:

A line drawn parallel to a side of an isosceles triangle will form another isosceles triangle.

Most pupils will draw the line parallel to one of the arms of the isosceles triangle and forget to consider the possibility of the line being drawn parallel to the base.

DRY ICE

Dry ice operates a newly invented target rifle in place of gunpowder. Since the ice evaporates completely to the inert gas carbon dioxide, there is no fouling of the gun, and enough crushed dry ice can be carried in the magazine of the .22 caliber rifle for 2,000 shots.

THE CORRELATION OF MATHEMATICS AND SCIENCE IN ONE UNIT

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In our junior high school we have followed the recent educational trend of having the teachers undertake two academic subjects with the same group of children—thus lessening the number of pupils to be taught and enabling the teacher to become better acquainted with her fewer pupils. The social sciences and English were combined, also the general science and mathematics. These are the four major subjects of our curriculum for grades seven and eight.

In working with my pupils in mathematics and general science I was interested in finding a topic that could well be used to integrate the two subjects. I decided upon a unit on "the Weather." The reading of weather instruments involves some mathematics but the main hypothesis to stand upon was the making of graphs to portray the day by day variation in the weather factors. The study of graphs by themselves as an isolated topic is not interesting to the pupils although it is a mighty important one considering the wide use made of them in newspapers, books, and magazines. In order to have the study of graphs vital to the pupils I decided that we would make and use them in our discussion of the weather.

Just as I was preparing to begin this unit with my pupils the newspapers had special articles explaining that the weather reports would not be given ahead of time and would be very niggardly—owing to war conditions. No records would be announced over the radio nor forecasts made several days in advance. We had planned to take these data for our graphs, but necessity forced us to obtain our own, which was much more worthwhile, but we could not compare ours with the official bulletins until receiving their report a month later.

The unit was introduced the first of January by asking the pupils what they had done during their Christmas vacation. To the question of "why" they had engaged in their various activities the reply was "because of the weather." Then we proceeded to list many ways in which weather and climate affect us—among them our sports, clothing, food we eat, work we do, health, and transportation. Two pupils made a circular pictogram with weather as the hub of a wheel, and each spoke naming

one thing affected by it with pictures on the rim for illustrations of each. We found out how very important weather is in our lives, and especially in the lives of business men. Newspaper articles showed us that women in Britain's Auxiliary Air Force were training to be meteorologists and the U. S. Army trains some of its men in the aviation division.

Next we collected weather signs and sayings finding many to be purely superstitious, others partly scientific, and a third group set aside to be labeled after we had more information on the subject. This part of our program of course exemplifies a main reason for studying the subject of science—to differentiate between the scientific and the superstitious, to be willing to change our preconceived belief in legendary material.

We decided to set up our own weather bureau station. Three pupils agreed to record the temperature each morning at 7:30; one living near the school, one on a high hill, and the third in a valley. One boy, furnishing his own materials, made a clever rain gauge of tin, glass, and a steel ruler. Wind vanes seemed very scarce in our vicinity so a boy scout with a compass observed a flown school flag. The only barometer available at school was a mercury one with a yardstick divided into eighths standing beside it. One boy bought two thermometers which he mounted on wood and to one bulb attached a piece of cotton leading to a little glass bottle strapped onto the wood framework. This served very well as a hygrometer.

For the first week of our graph work we confined ourselves to recording the temperature data on graph paper which each pupil had made for himself by drawing a series of vertical parallel lines spaced to match the horizontal ones on a sheet of their school composition paper.

Then for the month of February we built our graphs in earnest adding a line or bar or star each day. A blackboard in the rear of our schoolroom has three large sections which six pupils divided off into two-inch squares. Other pupils titled these "Relative Humidity," "Temperature Graph," and "Barometer Readings." We had to decide what intervals to use for our degrees of temperature, inches of air pressure, and per cent of humidity. We made these into line graphs and added one reading each day.

Two large pieces of white cardboard were used to make bar graphs of depth of rainfall and approximate wind velocity. After the first storm the pupils were very eager to find out if our rain

gauge maker had his instrument exposed to the elements. One boy kept a parallel record of actual weather compared to his almanac's day by day forecast. For illustrating wind direction an enlarged compass with sixteen points was drawn on blue paper. Then each day a small silver star was placed on the point marking the wind direction with the day of the month printed on it. At the end of the month we could easily "compute" our prevailing winds. We were offered the use of a 32″ by a 44″ glazed cardboard graph upon which we kept with three colored crayons the highest, mean, and lowest temperature readings for Boston, as reported in the newspaper by the U. S. Weather Bureau Station.

The first part of each period was utilized in recording the new data obtained and in discussing that recorded by the other two groups. The remainder of the period was spent in studying the various weather factors, performing experiments concerning them, understanding and reading weather instruments, interpreting weather maps, and learning more about the work of the U. S. Weather Bureau. A committee planned a trip to the East Boston Airport and Weather Bureau Station.

The interest in building the graphs justified the time spent each day in assembling them. Having three graphs on the rear blackboard made the pupils realize that a graph is not just a piece of squared paper with a crooked line. Every part of it must be labeled to give definite information and to be legible to the reader. At the end of February each pupil handed in one well made graph and also a summary of the weather for that month based upon our multiple recordings.

Each pupil contributed something as a member of our school weather bureau station; taking observations, recording them, making the graph background, printing the titles, making instruments, performing experiments at home, reporting on the lives of such men as Maury, Fahrenheit, Torricelli, Mr. Bentley of Vermont, lecturing on our film strips "Clouds," "Weather," "Graphs" or reporting on timely weather articles in the newspapers. It is one thing to be given a special report for one day and quite another thing to remember to keep a record of the temperature each day for a week. I was very much gratified with the faithful reporting and the fact that many others preferred to keep a graph of their own daily recordings. Of course, we had cases of absences which hindered the regularity of the reports.

We learned to appreciate the work of our "weather man" and we will be more lenient toward his future prophecies. We realize

how valuable accurate weather instruments are and with what care and accuracy records are kept. We also learned not to draw conclusions before we had enough supporting facts. And their teacher learned that pupils are willing to work outside of the classroom if there is a purpose and incentive behind the task.

A TIME SAVER IN TESTS

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I have been using a time saver in giving tests. I can correct and score thirty-five papers which call for fifty correct responses each, indicating on each paper which questions are correctly answered, which questions are incorrectly answered, and what correct responses were omitted, and do all the papers in a half an hour. It might be that there are other teachers who can use this idea to save time and energy.

The type of test is not new, but the procedure facilitates grading the tests. The correcting of the tests serves several purposes, some of which are:

1) It permits "mass correction" in marking the answers as to whether they are right or wrong, at no financial cost to the teacher. One can mark one hundred papers at one time nearly as easily as thirty papers.

2) It facilitates grading. After the papers are marked for correct responses, only a very brief time is required to count the number of correct responses and erroneous responses.

3) Class time is spent more profitably when the test is returned. No time is spent in answering the question "what should the answer be"; all the time is spent on why the answer is right or wrong. In many cases pupils can reason out why their answer is incorrect when they know the correct response, and time spent simply giving them correct responses which go unchallenged by them is time that could be spent on the questions that pupils challenge.

4) A teacher can give the same test to different classes of varying ability by a gradation in the difficulty of the questions and save time by virtue of the "mass correction."

There are also weaknesses, of course, some of which apply to all tests of this nature. These are in part:

1) It is too mechanical.

2) It is difficult always to have every response clear cut as to being correct or incorrect. Combinations can occur that were not anticipated.

3) This type of test functions to a more or less degree as an intelligence test.

4) It is hard for pupils to take this type of test until they become used to it. This should be borne in mind and a little practice by the pupil in making up a similar test should be given. It will definitely result in better understanding of what is expected of them in taking this type of test.

There is much which could be said on these points, but experienced teachers realize this.

The test is made up of formulas, nouns, adjectives, etc., at the top of a mimeograph paper and phrases, nouns, numerical values, etc., to the right. The test should provide for fifty or more correct responses. The paper is ruled to accommodate the items.

Now comes the time saving. I take three small nails and a hammer. With two of the nails I fasten all the test-papers, carefully stacked, to a mechanical drawing board. The top paper is one that has been checked as the key. I drive the third nail through the fifty or more squares that are checked on the top paper. This marks all the papers at one time. The papers are then removed from the board.

A glance at any paper will show the number of squares correctly checked. The score for the paper is the number right minus the number wrong. It might happen that a combination occurs where the answer is not very good, yet not absurd. These questions do not count either way. A red mark is hurriedly dashed across the squares that should have been marked by the pupil but were not, before returning the paper to the pupil. This takes very little time and avoids the possibility of pupils marking them after they are returned. It also serves to call the pupils' attention to responses he missed.

One important precaution is this, unless the test is mimeographed in approximately the same place on every paper, the nail holes will be in the wrong squares. If the squares are not too small, and if the top paper is punctured in the center of each square marked, then all the papers will be marked correctly. Out of one hundred tests there may be one or two that should not be used because the test is off center on the paper. These can be discarded when the tests are given out to the pupils.

Here is a sample test which is made up of only a few of the items which would be included in this test.

Division Physics Name Please

Place a check (√) in the rectangle where the top item either answers the one on the right, or is associated with it in our study of physics. Items may be used more than once. An example is given by the check below.

The Ammeter	The Voltmeter	Find R, when $K = 10.4$; $L = 50$ ft.; $d = .005$ in.	What is the ordinary house voltage?	Dry cell, open circuit	10 resistances of 120 ohms each in parallel will have what total resistance?	10 resistances of 120 ohms each in series will have what total resistance?	Find the resistance for 110 volts, 0.55 amps.	Voltmeter-Ammeter method	
									Measures IR drop
									Measuring current
									1.5 E. M. F.
	√								measures volts
									1200 ohms resistance
									20.8 ohms resistance
									is connected across the circuit
									30.6 ohms resistance
									110 Volts
									12 ohms resistance
									22 ohms resistance
									is connected in the circuit
									200 ohms resistance
									A method of measuring R
									Measures P. D.

CURRICULUM REORGANIZATION AND THE MATHEMATICS-SCIENCE PROGRAM

PAUL F. BOSTON
Superintendent of Schools, Greencastle, Indiana

LESTER B. SANDS
Assistant Professor of Education, DePauw University

[EDITOR'S NOTE. This article is the third and last of a series of articles on the mathematics and science curriculum. The first article, a self-rating Check Sheet for Progressive Practice in Elementary Mathematics and Science appeared in the March issue of SCHOOL SCIENCE AND MATHEMATICS. The second article, "Improving the Education of Mathematics and Science Teachers" appeared in the May issue.]

In two previous articles of this series, a pattern was developed for certain desirable changes to be made in the teaching of mathematics and science and in the training of teachers for these fields. It will be the purpose of this article to point out some of the barriers that have stood between traditional practice and the achievement of desirable changes in curriculum organization. To a large extent, the problems and recommendations which follow might apply equally well to subject fields other than mathematics and science.

It may be of interest and value to face quite frankly the fact that our profession of education has been delinquent in effecting a continuing process of evaluation and reorganization of our mathematics-science curriculum. This backwardness represents merely another instance among many in our conduct of social enterprises where we know better than we do. However, in justice to our profession, it may be fair to say that we have done definitely better in the field of education than has been done in most of the other social areas. Yet an honest confession may be not only good for our professional souls, but it may provide a taking off place for putting into practice some of our preaching.

Few educators believe in the old concept of the curriculum under which the large majority of our school programs continue to operate. Under this concept, curriculum is "stuff" to be memorized or recited. Mathematics and science are something to be poured into students. Life is something to prepare for rather than to be lived here and now. Effort is most worth while when it is hard and lacking in interest. Mind is something to be polished rather than used.

Under the newer concept of curriculum, and the one which we find so difficult to follow, the curriculum is life to be experi-

enced at the pupil's own level. The process is one of activity rather than receptivity. Purposeful living in the present becomes the ideal preparation for the changing world of tomorrow. Continuous child effort is secured through interest resulting from successful achievement in realistic situations. Opportunity is provided for pupil participation in experiences that satisfy both felt needs and social needs. Pupils share with the teacher and with each other in the privilege of constructing their school curriculum.

In the modern curriculum, the development of unified or core courses in mathematics and science is being encouraged. The present curriculum is carefully evaluated for the retention of all material that is basic and contributory to the modern aims of education. There is more investigation of problems through self-directed activities of the pupils and, to this end, there will need to be a movement toward a reduction of formal divisions between study and recitation. In such situations, the teacher becomes responsible for true leadership, stimulation, and guidance of the pupils.

The term *curriculum* as used here is defined broadly enough to include any activities or materials that constitute learning or the change of behavior in the child. There are, however, many barriers serving to block progress from the older to the newer conception of education. Difficulties may be localized in the ideas of parents, laymen, school board members, administrators, teachers, and pupils. From each group, pressures emerge to prevent changes in curricular philosophy, organization, and method.

In the following discussion, five significant problems will be considered in terms of the barriers they offer to changes in the mathematics-science program.

1. Our Subject-Centered Curriculum

One of the most obvious difficulties seems to lie in the fact that our curriculum in mathematics and science persists in being too subject-centered. This fact has been a serious deterrent to making the curriculum vitally functional. Our insistence upon mechanical mastery of skills in mathematics has accompanied a neglect for their utilization in situations that have meaning or significance to the learner. The study of algebra and geometry for five days a week during two years of secondary schooling probably represents a serious waste of time to many students

who are drawn into such a program. However, we wish to emphasize the value of these same courses when given to students who have particular need for them.

The standard secondary courses in science are also open to the same criticism. The steady proportional reduction in enrollment for chemistry and physics courses over the last forty years is a clear indication of the growing disfavor towards highly classified sciences. Apparently these sciences, in their extremely theoretical forms, function too insignificantly in the lives of many pupils. Again, those who are taking science courses and have specific uses for the highly technical learnings offered, can derive untold benefit from such courses. But every student is not aiming to become a scientist or inventor. In fact, he may have only cursory interest in the elaborations of departmentalized science although he may have keen and unflagging concern for the application of scientific principles to living in our machine age.

2. Meeting the Needs of Changing Society

We have been unpardonably slow in adjusting the mathematics and science curriculum to meet the demands of our changing civilization. For instance, it was perfectly stupid not to have paralleled the rapid growth of automobile usage with public school recognition of motor-vehicle safety, operation, and engineering. The programs of mathematics and science could have contributed greatly towards the solution of this social problem. The average high school adolescent is also keenly interested in pertinent phases of consumer education and in other areas very near to his everyday living. Yet the standard high school curriculum offers but incidental treatment of this significant problems. For example, the single problem of modern housing might cover a major proportion of the science area. It would include not only the study of structural materials and processes but would also involve the production of furnishings, utilities, landscaping, recreation, and other social implications of science.

Some educators may contend that the modern emphasis placed on science by the war will reinstate the classical curriculum in both mathematics and science. In view of the haste that is essential in the training of young men for the military services, it is hardly logical to expect that the extensive classical courses will find favor with modern militarists. The mathematics and science needed by the army, navy, and marine corps must be

functional. It must head into the applications of chemistry, physics, astronomy, and biology to military enterprises. With acceleration in secondary and higher institutions becoming the rule, there will be less time for the acquisition of theoretical laws. The students will be inducted into applied mathematical-scientific courses almost as soon as their training begins.

3. Meeting the Needs of Individuals

Our preoccupation with subject matter has also interfered with a needed recognition of pupil interests and individual differences in capacities. And what is probably more important, it has prevented desirable stimulation of creative and self-directed activities. In our practice we not only fail to encourage and develop the inherent creativeness of students, but we do not even conserve that which the young beginner brings to us. By the time pupils are exposed to several years of the conventions and inhibitions associated with our traditional school program, we find many of them at the place where their responsiveness is reduced to a yes, no, or a mere grunt.

We further conspire against a wholesome educational program through our elaborate system of marks and reports. As our grades actually indicate mastery of subject matter, they neither truly appraise the progress of pupils nor do they furnish us with bases for their improvement. A satisfactory appraisal system should convey to parents and pupils valuable information concerning a student's growth in concepts, understandings, interests, attitudes, skills, and response patterns. Even in many so-called progressive schools where modern report forms are in use, the administrative gesture has not been matched by corresponding changes in the curriculum or in the points of view of teachers. These practices reveal that we have far to go in learning to evaluate the child on the basis of his functional utilization of mathematics-science materials.

4. Administrative Problems in Curriculum Reorganization

Although administrators may recognize the attractiveness of the newer concepts relating to the mathematics-science program, they are considerably influenced from making changes by the protests of conservatives. The discouraging fact is that these critics are frequently unwilling to allow experimentation of any type. This problem must be met by the administrator with the

realization that he is responsible for enlightening both in-school and out-of-school groups about the need for progress. The administrator knows that he should not move too far ahead of his public and his school workers. But he also knows that improvements can be made only by reasonable boldness and persistence in leadership. Both the administrator and the teacher can be effective in improving practices through educational programs designed for school patrons and school personnel. The teachers of mathematics and science should play significant roles in such enterprises since their intimate knowledge of the problems in their fields qualifies them for that responsibility.

5. Preparation of Teachers for Newer Programs

American teachers are found to be well trained in the technical aspects of their particular fields and they are splendidly equipped with the personalities for student leadership. Whatever is needed in teachers by way of creativity, originality, initiative, and scholarship is now latent within the rank and file of American educators. But they are found to be in need of the philosophy essential to the vitalization of modern procedures. The correction of this deficiency calls for extensive periods of in-service training. Through curriculum committees, extension courses, workshop participation, summer school attendance, intervisitation and administrative stimulation, teachers may realize many improvements in their methods. To make progress towards the desired goals, teachers usually need only be shown the route for change and be given the necessary freedom.

6. Conclusion

In considering comprehensive changes in educational methods we should keep in mind that the American people have always sanctioned those new procedures which they have understood. Also, that, as educational leaders have enlightened the public and provided the essential conditions in the schools, improved practices have appeared. However, so long as fear, complacency, and carping criticism exists toward modern thinking, continuing progress towards the establishment of yet better procedures will be slow, though inevitable.

Know most of the rooms of thy native country before thou goest over the threshold thereof.—*Thomas Fuller.*

WILD FLOWER STUDY AND CONSERVATION

CHARLOTTE L. GRANT
Arsenal Technical High School, Indianapolis, Indiana

Few high schools have the opportunity of studying trees, wild flowers, and birds in their native haunts. Arsenal Technical High School of Indianapolis, Indiana, enjoys this rare privilege. On its campus of seventy-six acres are still found four and one-half acres of virgin forest. In 1926 this area was fenced and placed under the care of the botany department. It has been dedicated to the purpose of acquainting boys and girls with plants and animals as they live in the out-of-doors.

The original flora of the tract has been greatly enriched by the addition of many species of trees, flowers, and ferns native to Indiana. At the present time nearly four hundred species constitute the vegetation in the nature preserve. Six different habitats are in evidence. These are: forest, prairie, sand, rock, pond, and pond-edge. A peat bog now being developed will add another habitat. A small stream winds through the wooded preserve. Large boulders and limestone rocks have been brought in to construct the rock gardens. An open sandy slope resembles the sand dunes and other exposed habitat sites of the state.

Students have helped in the construction and maintenance of the various habitats. Many have transplanted wild flowers from woods near their homes or from forested areas near relatives in the country. Students have been taught never to pick the wild flowers, but are encouraged to bring the entire plants with roots well covered with soil. Pots, boxes, paper bags or baskets are used for this purpose. With the help of teachers, these plants are placed in the proper habitat of the preserve. As they grow and blossom from year to year the student views his contribution to the plant population with pride and joy. He has learned to protect rather than to destroy wild life.

Teachers often bring potted wild flowers into the classroom for their classes to identify by the use of simple keys. Mimeographed drawings of wild flowers are then distributed and students color to show characteristics of leaves, stems, and flowers. Notebooks are often kept, or calendars are designed to show places, dates, and finders of various wild flowers. These are placed on bulletin boards and daily additions are made. This year several classes have made maps of the preserve to show the various habitats. Small numbers, letters or other symbols are

used to indicate flowers in bloom. A key to the symbols is kept on a separate sheet.

In the spring, members of the science club place small cards bearing the common names of the plants on wire stakes beside specimens in bloom. Thus, students become conscious of the abundance of spring flowers. Cards with numbers often replace the name plates. Most species are sufficiently numerous that the location of the number tag differs from that of the name tag. Classes may be divided into small groups, each guided by a capable leader, and tests are given on recognition of the wild flowers in their native haunts. Thus, it is possible to use the nature preserve as a project in conservation, an outdoor laboratory, and a testing device.

INTEGRAL SOLUTIONS OF HARMONIC EQUATIONS

ARTHUR B. HUSSEY
New Rochelle High School, New Rochelle, New York

Much interest has been shown in integral solutions of the Pythagorean form $x^2+y^2=z^2$; discussions vary from brief and elementary treatment in secondary algebra textbooks to analyses such as those of Lewis W. Colwell (SCHOOL SCIENCE & MATHEMATICS, 351, 619 (1940)). The availability of these solutions to the teacher of physics has greatly facilitated the devising of types of problems in which the pupil's energy is directed to the reasoning involved, rather than to arithmetical operations.

The harmonic equation, $1/a+1/b=1/c$, occurs fully as frequently; every elementary physics course uses this equation in the forms $1/R_1+1/R_2=1/R$ (for combining electrical resistances in parallel) and $1/p+1/q=1/f$ (the conjugate focal distance formula), and many include treatments of the focal length of two thin lenses in contact and of the focal length of a lens of given index and radii of curvature which lead to this equation. Other examples occur elsewhere in science. However, examination of textbooks shows either very little endeavor to give in problems data which lead to solutions simple in their arithmetical computation, or else repetition of a very few such values. It is possible rapidly and with little mental effort to obtain values of a and b which will lead to integral values of c

in the equation $1/a+1/b=1/c$, a concise and general procedure being the following.

Choose any two integers (e.g., 2 and 3); multiply each by their sum (5); the products (10 and 15) are the required values of a and b. Incidentally, the instructor also knows the value of c, as well; it is the product of the original numbers chosen (in this case, $2 \cdot 3 = 6$).

$$\frac{1}{10}+\frac{1}{15}=\frac{1}{6}.$$

It is wise to practice this outline a few times with different numbers, until the procedure becomes a routine one.

It will be noted that choosing the original numbers from the smaller ones, 1, 2, 3, 4, 5, leads to variety sufficient to avoid repetition and keep interest awake. It is evident that if the chosen numbers are not prime to each other, the values obtained will be integral multiples of a smaller set of values; however, the larger set is quite valid.

Carrying through the suggested procedure in general terms shows that it must result in integers that satisfy the harmonic form. Let the original pair of numbers be m, n. Each, multiplied by their sum $(m+n)$, gives $m(m+n)$, or $n(m+n)$. Then the equation $1/a+1/b=1/c$ has the form

$$\frac{1}{m(m+n)}+\frac{1}{n(m+n)}=\frac{n+m}{mn(m+n)}=\frac{1}{mn}$$

in which the denominator on the right side, mn, is an integer. If a complete set of values is desired, it is necessary to add to the sets of values of a, b, and c found by this method, all integral multiples of these values of a, b, and c:

$$\frac{1}{km(m+n)}+\frac{1}{kn(m+n)}=\frac{1}{kmn}$$

(except when k is a square, these values having been obtained by the original procedure). There is little interest, practically, in these additional values.

Correct results are obtained when one of the original two numbers chosen is negative. Hence conjugate focal distances can be given for the case when the lens is diverging or, by changing all the signs obtained in this way, for the case of a converging lens producing a virtual image. This, if $m=3$ and $n=-1$,

$m+n=2$ and

$$\frac{1}{6}+\frac{1}{-2}=\frac{1}{-3} \quad \text{and} \quad \frac{1}{-6}+\frac{1}{2}=\frac{1}{3}.$$

Here are tabulated the first few integral values found by the method discussed.

m	n	a	b	c
1	1	2	2	1
1	2	3	6	2
1	3	4	12	3
1	4	5	20	4
2	2	8	8	4
2	3	10	15	6
2	5	14	35	10
3	4	21	28	12
3	5	24	40	15
4	5	36	45	20
2	−1	2	−1	−2
3	−1	6	−2	−3
3	−2	3	−2	−6

these, signs changed, give

		−2	1	2
		−6	2	3
		−3	2	6

Example where $k=2$:

1	1	4	4	2

SAFE AND DURABLE X-RAY MACHINES

X-ray machines that will stand up to hours on end of hard use under the severe conditions of military service and be perfectly safe, are assured by rigorous tests carried out by the National Bureau of Standards.

The requirements are so severe, Bureau officials said, that most machines failed to make the grade the first time they are tested. Then they must be remodeled and often the new model fails also. Sometimes models have been sent back half-a-dozen times before a machine was produced that could meet the strenuous military requirements.

These machines are used to test the physical fitness of inductees, to examine injuries at army hospitals, to test materials in shipyards, airplane factories and other plants producing war materials.

EASTERN ASSOCIATION OF PHYSICS TEACHERS

One Hundred Fiftieth Meeting
HARVARD UNIVERSITY
Cambridge, Massachusetts

Saturday, May 16, 1942

PROGRAM

9:45 to 11:00 Symposium: Relation of Physics to Aviation.
Sponsored by the Secondary School Wartime Education Committee at the Harvard University School of Education.
(An important announcement regarding the policy of the government will be made at this time.)

11:00 to 12:00 Address: The Power Plant of a Plane.
William Leary, Research Associate, Gas Engines, Massachusetts Institute of Technology.
Sponsored by the Harvard University Graduate School of Education.

12:30 Luncheon at the Harvard University Faculty Club.

AFTERNOON SESSION

2:00 Business Meeting.

2:15 Army Needs in Physics Training, by Captain Benjamin C. Bowker, U. S. Army.
Navy Needs in Physics Training, by Ensign Charles A. Sweet, Jr.

BUSINESS MEETING

The following were elected active members:
Mr. Arthur G. Brown, North Kingstown High School, Wickford, R. I.
Mr. Robert R. Sweeney, Rindge Technical School, Cambridge, Mass.
Miss Genevieve McGlinchey, Cambridge, Latin School, Cambridge, Mass.

Report of Nominating Committee

The nominating committee presents for your consideration the following list of officers for the coming year:
For President: Mr. Alfred C. Webber, Brookline High School, Brookline, Mass.
For Vice-President: Mr. Clarence W. Lombard, Hyde Park High School, Hyde Park, Mass.
For Secretary: Mr. Carl W. Staples, Chelsea High School, Chelsea, Mass.
For Treasurer: Mr. Albert R. Clish, Belmont Junior High School, Belmont, Mass.
For the Executive Committee:
Mr. Hollis D. Hatch, English High School, Boston, Mass.
Mr. Charles S. Lewis, Brighton High School, Boston, Mass.
Mr. Louis R. Welch, Dorchester High School for Boys, Dorchester, Mass.

Respectfully submitted,
W. W. OBEAR

The above were elected for the ensuing year.

It was voted to express to Mr. Preston Wood Smith the thanks and appreciation of the Eastern Association of Physics Teachers for his excellent work as Treasurer of the Association for the past eight years.

A vote of regret of the loss of Mr. Fred R. Miller to the teaching profession, in view of his retirement from teaching, and an expression to him of the thanks and appreciation of the Association for his services to the organization during so many years, was passed.

Symposium; Relation of Physics to Aviation.

Sponsored by the Secondary School Wartime Educational Committee of the Harvard University School of Education.

Opinions of the speakers were given as to what secondary schools should do in regard to training for aviation and defense industries.

In aviation the idea was to anticipate the aviator's training. Special work in high school was recommended in physical training, mathematics, airplane recognition, and map-reading.

Aviation in the last war was relatively simple, the V-25 having about a dozen instruments, whereas the modern airplane may have 150 instruments, levers, and buttons. Increased time is necessary in training due to advances and more complicated machines.

High Schools could help, it was said, in the following:

1. Physical fitness, developing
    a. Self-confidence,
    b. Team-work
    c. Sports, foot-ball, hockey, boxing, wrestling, etc.
2. Curriculum.

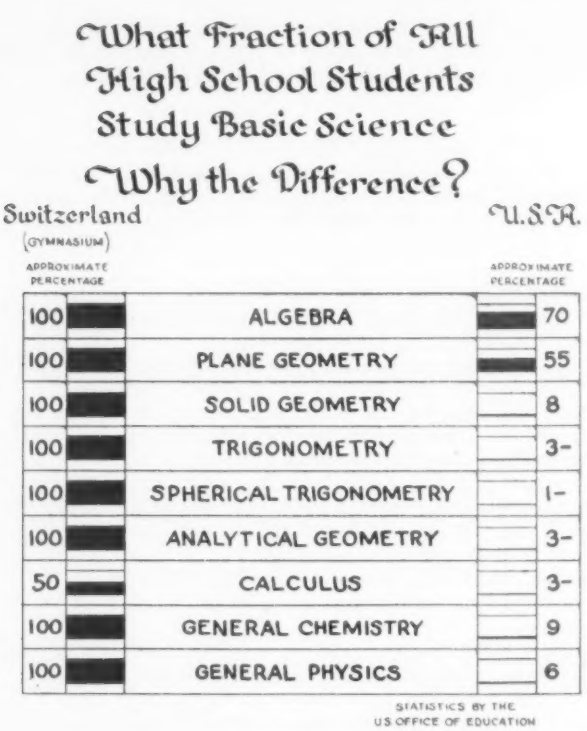
The army, it was said, does not wish to interfere with normal education any more than necessary. Certain subjects essential to air-force were mathematics, algebra, plane geometry, and trigonometry; physics with special view to problems in aviation aeronautics was desirable; meteorology, and air-plane recognition.

3. Civil Course.

Professor Robert Ulrich, of the Harvard University School of Education spoke of School systems here and in Europe.

Captain Leighton Brewer spoke briefly, and Captain William Bohnaker, recently from the Philippines and Java stressed the importance of good physical condition in aviation, working under conditions where the individual is "oxygen-starved." He emphasized the teaching of self-reliance, and thorough understanding of problems and equipment, saying that many in V-40 machines in the Philippines were killed because of lack of mastery of their machines. The fliers must have more training, and more time in this would have saved many lives.

Mr. L. R. Kirk spoke briefly on the question of mathematics and basic science in the secondary schools, submitting the following chart compiled from statistics of the United States Office of Education. He also showed a chart "Arithmetic as Applied to Design of Chevrolet Cars and Trucks," which is available.



Mr. Russell Hilliard, State Director of Aeronautics for the State of New Hampshire spoke of the evident confusion about what was needed, and mentioned a course on the Principles of Aeronautics for next year, copies of which, he said, would soon be available in mimeographed form from the New Hampshire State Department of Education.

He suggested physics and mathematics courses with aeronautics. Education had neglected the impact of auto-transportation on the lives of pupils. If this had not been true, a better accident record would have resulted. In the same way a Civil Aviation Course as a permanent requirement might be an aid to safer aviation both during and after the war.

Courses in teachers' colleges were recommended, the teacher not to receive a certificate in aviation-teaching, unless some instruction in airplane, including actual flight had been received.

The program in Civil Aeronautics suggested by the U. S. Office of Education was:

1. Teaching of aviation in the schools.
2. Air-conditioning in all grades in all subjects.
3. Courses in aeronautics in the summer.
4. Courses in aeronautics next year.

The United States was organized to help teachers in these.

It was not suggested that the Black and Davis type of Physics course or present mathematics courses should be dropped, or that these courses should be infiltrated with a year of aeronautics or meteorology in physics.

By fall there will be more material than can be used.

The more physics the pupils have the better off they will be.

The State Department of Education was setting up a Bureau, not to dominate or tell what to do, but for service and dissemination of material such as bibliographies, slides, and the like.

Other speakers were Dr. Edgar Fuller, Education Consultant of the Civil Aeronautics, and Captain Stanford Chester, representing General Henry A. Arnold, Chief of the Army Air Force, Washington, D. C., who stressed the weakness of many in their background in mathematics and physics.

Mr. William Leary, Research Associate Gas Engines, Massachusetts Institute of Technology gave an address on the "Power Plant of a Plane," illustrated by many slides, and explaining the principal improvements in airplane engines since the first twelve-cylinder machine. The most important modifications were the following:

1. Addition of the supercharger.
2. Improvement in mechanical details such as valves, etc.
3. More complete understanding of vibration problems.
4. Improved quality of fuels and lubricants
5. More horsepower for same volume, and less weight per horsepower.

ARMY NEEDS

Abstract of Address by CAPTAIN BENJAMIN C. BOWKER

Captain Bowker spoke on the army needs in the matter of training in physics. He said there were two sides of the situation. The first was the official army requests and needs. As given out by the Secretary of War, the six points the army needs and expects of men coming in were:

1. *Capacity for clear, accurate expression.*

In this respect, for military purposes, what one gets out of science courses is as important as what one gets out of English classes.

2. *Ability to do mathematical computations accurately and with comparative rapidity.*

One cannot work out physics problems unless properly grounded in arithmetic.

3. *Must have a clear general picture of some exact science.*

Physics is the basis as far as the army is concerned. The first question asked is whether one has had any physics or how much.

4. *Should have a clear understanding of the use of maps and charts.*

Maps may have to be "dragged in."

5. *Should be qualified to take care of selves physically under almost all conditions.*

6. *Should have good health and hard physical condition.*

The other side is the criticisms of present training.

1. Many schools say emphasis is on men 22–23 years of age, who have been out of school four or five years, have had no use for physics, and have forgotten. They need to brush up in the subject.

The biggest stumbling block is lack of knowledge of the fundamental principles of electricity. There are miles of red tape in the army, and miles of electric wire, and the wires grow longer. Thorough knowledge of Ohm's law and megnetism is needed. The army has not time to dwell on these.

2. *Inability to apply what one knows in a logical manner.*

Pupils in the schools should be *taught to think.* They should be taught *principles,* given facts which aren't in Black and Davis, allowed to try to analyze and work them out. This is hard for them. They should be given help in the reasoning process.

3. *If practical problems with modern machines were given,* interest would be stimulated.

4. *Not enough mechanics.*

It is assumed the boy grew up with a working knowledge of how machines operate, etc. Many never had the hood up in an auto. A little more emphasis on the nomenclature of parts would be desirable.

5. *Internal combustion engines* make the army go. Many principles of physics center about these machines.

6. Some of the topics that should be emphasized are Newton's laws, simple machines, a little horsepower, and many problems in using arithmetic and *getting the right answer.*

When possible, every branch of the army is made easier if one knows the slide-rule.

Engineers need as much algebra as possible; electricity; thermodynamics, including heat transfer, insulators, and B.T.U.'s.

Two years of physics instead of one is recommended.

The army air-forces need more physics. If applicants know electricity, they are forty hours ahead. The army air curriculum is as follows:

Radio code		50 hours
Math.	Elementary plane trigonometry Spherical trigonometry Slide rule	20 hours
Maps, charts, aerial photography		12 hours
Aircraft recognition		8 hours
Military ground force tactics		6 hours
Customs, courtesies, etc.		3 hours
Safe-guarding infantry		3 hours
Signal communication		1 hour
Organization of air forces		10 hours
Organization of navy forces		10 hours
War Department Publications		2 hours
Chemical Warfare		2 hours
Physics		20 hours

Physics is taught from War Department Manuals, each 20 to 30 pages. If the applicant has had more physics the time on that subject could be cut. The army does not expect the teachers to teach army business.

NAVY NEEDS

Abstracts of Address by ENSIGN CHARLES A. SWEET, JR.

The navy is most complex. All branches of science are made use of. The battle fleet is a technical affair. It consists of:

1. *Submarines* (the most compact mass of mechanism known). Every inch of space is crammed with mechanisms. They are the scouts that notify the fleet of the position of the enemy.
2. *Detroyers.*
3. *Heavy cruisers.*
4. *Light cruisers.*
5. *Battleships.*
6. *Carriers* (100 miles back). These are the eyes of the fleet. They cut enemy's speed to bring battleships into action.

The men have to be trained for this work.

Officers are divided into four categories:

1. Annapolis men. (Training based on mathematics and physics.)
2. V-7 program school. (20% flunk, 17% from failures in physics.)
3. V-1 program school. Senior year in high school.
4. Specialists from civil life (mathematics and physics).

(Into navy at end of college. This leaves most to college, but much physics and mathematics.

Enlisted men. (Math. and Physics.)

The navy has a wider variety of opportunities and classification than the army. A special pamphlet gives ratings. The importance of science and mathematics is stressed, especially electricity, Ohm's law, and mechanics. Emphasis is also placed on its reconstruction value.

HELIUM PRODUCTION TO BE GREATLY INCREASED

Helium, only non-inflammable gas suitable for balloons, will be produced in greatly increased quantities to keep aloft more blimps for coastal submarine patrol, to inflate barrage balloons, for deep-sea diving and for medical and scientific uses, states Dr. R. R. Sayers, director of the U. S. Bureau of Mines. Congress has appropriated $4,000,000 for this purpose which will be made available from Navy Department funds. Production will be stepped up to several times last year's figures.

Helium, element first found in the sun, is now obtained from Texas natural gas. For some years past, the Bureau of Mines plant at Amarillo has been the only helium plant in the world and has given the United States a world monopoly of the valuable gas. Now a new plant will be erected at an undisclosed location, and Bureau geologists are searching for other helium-producing fields.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1763. *W. R. Smith, Suttons Bay, Mich.*

1761. *D. F. Wallace.*

1759. *Howard D. Grossman, New York City.*

1765. *Proposed by J. Seward Bodine, Salt Lake City, Utah.*

If $z^n = x^n + y^n$, show $z^m > or < (x^m + y^m)$ according as $m > or < n$

Solution by Aaron Buchman, Buffalo, N. Y.

If x, y, or z are negative, the required relation is not true, as can be seen by letting $z = -1$, $x = 2$, $y = 3$, $n = 1$, and $m = 2, 3, \cdots$

Therefore let x, y, z be positive.

Then

$$z > x \quad \text{and} \quad z > y. \tag{1}$$

Also

$$z^a > x^a \quad \text{and} \quad z^a > y^a. \tag{2}$$

Let

$$m = n + a.$$

Since

$$z^n = x^n + y^n. \tag{3}$$

Then $z^m = z^a z^n = z^a x^n + z^a y^n$. But from (2) $z^a x^n > x^a x^n$ and $z^a y^n > y^a y^n$. Thus $z^a x^n + z^a y^n > x^m + y^m$. And

$$z^m > x^m + y^m. \tag{4}$$

Let $m = n - a$. From (3) $z^m = z^n/z^a = x^n/z^a + y^n/z^a$. But from (2) $x^n/z^a < x^n/x^a$ and $y^n z^a < y^n/y^a$. Thus $x^n z^a + y^n/z^a < x^m + y^m$. And

$$z^m < x^m + y^m. \tag{5}$$

The relations in (4) and (5) are true for all rational and irrational values of x, y, z, n, and m; and for positive and negative values of n and m.

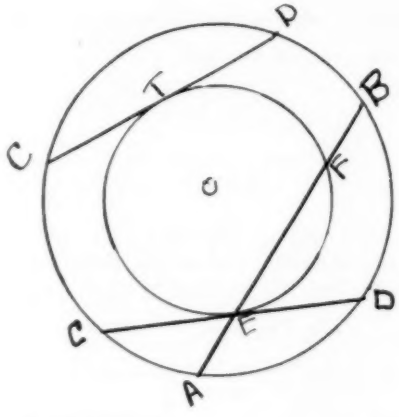
A solution was also offered by Hugo Brandt, Chicago, Ill.

1766. *Proposed by Isabella Moore, Boston, Mass.*

In a given circle draw a chord of fixed length which shall be bisected by a given chord.

Solution by Lucio Chiquito, Medellin, Colombia, S. A.

Let AB be the given chord; CD, the one to be drawn, and $AB > CD$. In any position we draw the chord CD and after this we construct a new circle with center O tangent to CD. All chords equal to CD are tangent to this circle. As $AB > CD$ this circle cuts AB in two points, E, F. The tangent to this circle in E or F is the chord to be drawn.



If $AB = CD$ the chords coincide.

If $AB < CD$ there is no solution.

Solutions were also offered by D. F. Wallace, Minn., Isabelle Moore, Boston, Mass., Aaron Buchman, Buffalo, N. Y., and Ruth Childe, Rutland, Va.

1767. *Proposed by Elizabeth Vreeland, Baileytown, N. Y.*

Divide a given triangle into two equivalent parts by a line perpendicular to one of the sides.

Solution by Malcolm Kirk, West Chester, Pa.

Since the area of a triangle is half the product of any two sides times the sine of the included angle, it follows that $x^2 \cos B = (AB \cdot BC)/2$. From which

$$x = \sqrt{\frac{AB \cdot BC}{2 \cos B}} = BE.$$

Now x can be constructed in the usual manner and thus E is determined. Then draw a perpendicular EF to BC, and this line divides the triangle into two equivalent areas.

Solutions were also offered by Aaron Buchman, Buffalo, N. Y.; Hugo Brandt, Chicago, Ill.; Jane Mooney, Bull's Head, N. Y.; Margaret Laboyteaux, Covert's Cove, N. Y.; Margaret Conley, Tyre, N. Y.; Virginia Thayer, Lexington, Ky.; Norman Anning, University of Mich.; D. F. Wallace, Minn.; Mrs. Walter R. Warne, Rochester, N. Y.; Agnes Dunlap, Montreal, Canada; Lois Kragenbring, San Francisco, Calif.; Walter R. Warne, Rochester, N. Y.; Hazel Holt, Buffalo, N. Y.; Florence Comstock, Sayre, Pa.; Scobey Warne, Union Hill, N. J.; Alice Languth, New Orleans, La.; Emma Cantwell, Atlanta, Ga.; the proposer; Lucio Chiquito, Medellin, Colombia, S. A.

1768. *Proposed by Florence Dean, Cayuga, N. Y.*

If

$$\frac{x}{a-y^2}=\frac{y}{a^2-x^2}=\frac{1}{b}$$

and if $xy=c^2$, show that when a and c are unequal $a^2+c^2-b^2=0$.

Solution by Norman Anning, University of Michigan.

The given equations can be written

$$y^2+bx=a^2, \tag{1}$$

$$x^2+by=a^2, \tag{2}$$

$$xy=c\,. \tag{3}$$

For convenience, let

$$x+y=s. \tag{4}$$

It is required to find the condition on a, b, and c that equations (1), (2), (3) may be consistent. This will be done by eliminating x, y, s from equations (1) to (4).

If we add x times (1) to y times (2),

$$xy(x+y)+b(x^2+y^2)=a^2(x+y),$$

or

$$c^2s+b(2a^2-bs)=a^2s.$$

From this we have

$$2a^2b=s(a^2+b^2-c^2). \tag{5}$$

If we add equations (1), (2) and twice (3),

$$s^2+bs=2a^2+2c^2. \tag{6}$$

From the elimination of s from (5) and (6) there follows, after a page of "executive" algebra.

$$(a^2+c^2-b^2)(a^2-c^2-bc)(a^2-c^2+bc)=0.$$

As a consequence, $a^2+c^2=b^2$ is a sufficient but not a necessary condition condition that equations (1), (2), and (3) may be consistent.

Solutions were also offered by Walter R. Warne, Rochester, N. Y.; Blanche Gilgan, Lancaster, Penn.; Arthur Danzl, Collegeville, Minn.; Roy Waugh, Madison, Wis.; Abbe Taylor, Quebec, Canada; Margaret L. Hayes, Halifax, Nova Scotia and the proposer.

Editor's Note: Mr. Hugo Brandt, Chicago points out that a and c may be equal or unequal. Thus from $b^2=a^2+c^2$, if $a \geqq b/2\sqrt{2}$, $c \leqq b/2\sqrt{2}$, and hence $a \geqq c$. The relation $a<c$, may also hold.

1769. *This problem apparently was mis-stated.*

1770. *Proposed by Grace Brown, Washington, D. C.*

Solve for x:

$$\sqrt{\frac{x+a}{x}}+2\sqrt{\frac{a}{x+a}}=b^2\sqrt{\frac{x}{x+a}}.$$

Solution by David Rappaport, Chicago, Ill.

Multiply by

$$\sqrt{\frac{x+a}{x}}$$

$$\frac{x+a}{x}+2\sqrt{\frac{a}{x}}=b^2. \tag{1}$$

Then

$$1+\frac{a}{x}+2\sqrt{\frac{a}{x}}=b^2 \tag{2}$$

$$\left(1+\sqrt{\frac{a}{x}}\right)^2=b^2 \tag{3}$$

$$1+\sqrt{\frac{a}{x}}=\pm b \tag{4}$$

$$\sqrt{\frac{a}{x}}=b-1 \tag{5}$$

$$\frac{a}{x}=(b-1)^2 \tag{6}$$

$$x=\frac{a}{(b-1)^2}. \tag{7}$$

In (4) the use of the minus sign leads to $x=a/b+1$ which is an extraneous root.

Solutions were also offered by Walter R. Warne, 11 Gardiner Park, Rochester, N. Y.; D. F. Wallace, Minn.; Norman Anning, Mich.; Blanca Magrassi, San Antonio, Tex.; Lucio Chiquito, Medillen, Colombia, S. A.; Hugo Brandt, Chicago, Ill.; Grace Brown, Washington, D. C.; Arthur Danzl, Collegeville, Minn.; Mrs. Ernest O. Lansing, Montreal, Canada; Roy C. Warne, Adrian, Mich.; Emma P. Cantwell, Atlanta, Ga.; William A. Warne, Bull's Head, N. Y. and Walter R. Warne, Rochester, N. Y.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

PROBLEMS FOR SOLUTION

1783. *Proposed by Harry Gwinner, Jackson, Miss.*

A triangular pyramid $V-ABC$ has dimensions:
$AC=10$, $AB=16$, $BC=18$, altitude $VO=20$. The vertex, V, is in a line perpendicular to the base at the center of the inscribed circle of the base. Find the angle between the faces VAB and VAC.

1784. *Proposed by Paul D. Thomas, Durant, Okla.*

Show that

$$\sum_{n=0}^{\infty} \frac{1}{n^2+5n+6}=\frac{1}{2}.$$

1785. *Proposed by Cecil B. Read, Wichita, Kan.*

In any triangle obtain a formula for the distance between the centers of the circumscribed and inscribed circles.

1786. *Proposed by Walter M. Sackett, Jr., Evanston, Ill.*

Solve for all values of x in circular radians in equation,

$$\cos^2 x+3=0.$$

1787. *Proposed by Walter M. Sackett, Jr., Evanston, Ill.*

In the identity $(a+ib)^{c+id}=x+iy$, find x and y in terms of a, b, c, and d.

1788. *Proposed by Owen Saunders, Gainesville, Texas.*

Three equal circles with radius, x, are tangent each to the other two. The area encolosed by the circles (minor arcs) is one acre. Find the diameter of a circle.

SCIENCE QUESTIONS

October, 1942

CONDUCTED BY FRANKLIN T. JONES
10109 Wilbur Avenue, S.E., Cleveland, Ohio

SCIENCE AND WAR IN THE FALL OF 1942

We passed through the summer of 1942 without an air attack upon continental United States (at least up to the date of writing, August, 1942).

We have seen the emphasis of war pass to supremacy in the air. We now think in terms of the properties of the atmosphere up to 35,000 and 40,000 feet. Air Raid classes are posting the civilian population of the entire country upon methods of fire fighting and the properties of incendiary, explosive, fragmentation, and demolition bombs. The properties of wartime gases must become matters of common knowledge. The better both incendiaries and their like and gases and their like are understood, the easier it becomes to meet their attacks.

The formula for kinetic energy becomes an easy method of explaining the damage caused by a falling bomb. Velocity, energy (in foot-pounds), penetration, pressure waves, and all the vocabulary which once were mere mysteries of the physics class and laboratory are now matters of vital knowledge which may spell for any one of us the difference between life and death. At last our *interest* is aroused!

Shall the school continue to teach academic physics and chemistry and weather and bacteriology, or shall it grasp the opportunity to supply to

all people, particularly to boys and girls in science classes, life-saving information adapted to present day needs?

There should not follow any sacrifice of scientific method or procedure. All scientific knowledge can be imparted with a vigor never before approached and we shall find our pupils and their families absorbing scientific knowledge along with these daily practical applications.

In view of this situation, the motto of the SCIENCE QUESTIONS Department for 1942 is repeated—

KEEPING UP WITH SCIENCE AND INDUSTRY

THE BIG QUESTION FOR THE FALL OF 1942

975. *What shall schools do to meet the peculiar demands of the present situation?*

An Answer—By Arthur O. Baker, Supervisor of Science, in the Junior and Senior High Schools, Cleveland, Ohio (Elected to the GQRA No. 430).

Human activities are no longer limited by the boundaries of land and sea. Man has learned to fly and to communicate through the air. Phenomenal developments in the fields of radio and aeronautics have placed us in an Air Age. Hence, through the use of huge cargo planes weighing 80 tons, flying at 300 miles per hour, with a range of 7,500 miles and through transmission of messages of commerce by radio more of the resources and commodities of the world will be brought to the people in industrial America.

Clearly, it is evident that both passengers and freight are going to be transported increasingly through the air. For safety against air attacks of "airminded enemies" further decentralization of cities, industries, and homes may occur. Extensive private ownership of planes is coming, following the conclusion of the war. Real estate developments may include the subdividing of land around community airports or landing fields into plots for homes. Garages, to the rear of such plots, will become hangers for privately owned planes.

Such may be the shape of the things to come in the Air Age of tomorrow. In the Air Age of today we are confronted with the grim job of winning the war. The handwriting on the wall indicates that he who gains mastery of the air wins the war! Hence, our thinking, planning, and energies need be directed to this one supreme goal—the winning of the war through air power! The American mind must be "air conditioned" for the Air Age.

What shall the schools do to meet the peculiar demands of the Air Age? Specifically, we should cooperate with the U. S. Office of Education and the Civil Aeronautics Administration in their suggestions for bringing the realities of the Air Age into the curriculum and for providing pre-flight training.

Topics which have too frequently carried a role of minor importance in science courses in the past, now become significantly worthy of major emphasis. Such topics pertain to the fields of physical geography, geology, meteorology, astronomy, and navigation.

Teachers of General Science should vitalize their teaching by stressing the relation of man to the atmosphere, by analyzing weather conditions and weather maps, and by training pupils in weather prediction.

Biology teachers, too, can contribute to the "air conditioning" process. Opportunities should arise in biology classes for studying flight principles which may be observed in flying organisms; streamlining in Nature; effects of pressure, temperature changes, and travel at high speed of

human beings; use of the airplane in disease control; and physical fitness for the Air Age.

A direct approach should be made in Physics classes to certain aspects of aeronautics. A major treatment of aerodynamics, airplane engines, meteorology, and avigation would seem desirable.

Chemistry teachers should have a part in the program also. Topics from physical geography and geology might well be included as the chemistry of light weight metals, valuable minerals, and liquid fuels are studied.

Even more specifically school systems should install pre-flight courses in which certain materials from the fields of mathematics, physics, and industrial arts might be studied in their relation to aeronautics.

SCIENCE AND FIRST AID

A copy of the American Red Cross First Aid Text-Book *should be in the hands of every science teacher, social science teacher and principal. This book lays stress rather upon procedures than upon reasons. It is very careful to warn the First-Aider against trying to do the doctor's job as well as his own. However, the science teacher can use this book reliably for procedures and give a great many scientific explanations that will make the First-Aider work more intelligently.*

The following questions indicate some of the general ways in which the teacher can readily arouse interest in science through life-saving methods—

976. Q. What are the four essentials of proper first aid work?

Answer—From the poster of one of the very large industrial chemical companies—

1. *Control of bleeding.*
2. *Control of breathing.*
3. *Treatment for poisoning.*
4. *Treatment for shock.*

The teacher will readily see that here is a reason for a thorough study of physiology for (1), (2) and (4), and for a host of applications of chemistry in (3).

It is recommended that the teaching of all first-aid procedures follow the Red Cross text-book (Edition of 1940 and subsequent). It can be expected that this and subsequent revisions will keep the teacher and reader up-to-date with the very best practice. (NOTE—In my edition, 1940 corrections, two important changes should be made, and are recommended by *RC*, whenever *patient* is used, say *victim*, and, in Artificial Respiration, change maximum pressure to be used from 60 pounds to 40 pounds. FTJ.)

A list of 100 "Study Questions in First Aid" has been prepared for those trying for an Air Raid Warden's certificate. If the Editor receives a sufficient number of requests, either the entire list or a list of selected questions will be published in this Department.

FLUORESCENT LIGHTING

977. "A few years ago you gave me some valuable suggestions for the Relaxation Circuit (Neon Tube). At present I am interested in fluorescent lighting.

"Have you any experiments or demonstrations in this field suitable for elementary school pupils?"

(*Please reply through* Science Questions Department. FTJ.)

Proposed by Lillian A. MacDonald, GQRA No. 327, South Side High School, Newark, N. J.

RUBBER

978. *Suggested by articles in the daily press.*

Are you following and trying to understand the arguments about rubber?

Have you made a list of the commercial names used for the various synthetic rubber products? Please send them in.

A partial answer—Copied from an enclosure received with a dividend check from a prominent chemical manufacturer (Dividend rate is only 3%—the same as paid by the Federal Savings & Loan Assns. FTJ.)

"This fall The Dow Chemical Company in co-operation with Thiokol Corporation, Trenton, N.J., will be producing 'Thiokol' synthetic rubber for retreads at the rate of 2,000 tons a year. By the beginning of 1943, it is anticipated that a yearly production of 30,000 tons will have been realized —sufficient to retread 1,000,000 tires a month—five pounds being required for each retread! For the present all that Dow can make will go to retreads needed in vital war industries. From experience 5,000 miles seems a conservative estimate for these retreads. Complete tires now being made in experimental quantities, show 7,500 to 10,000 miles.

The product in question is a thermoplastic material resulting from the chemical reaction of ethylene dichloride from salt and oil and sodium polysulfide from salt and sulphur. Starting in 1930, Dow supplied the necessary chemicals to the Thiokol Corporation, but since 1938 has been making the crude synthetic rubber.

"Since Pearl Harbor much progress has been made by Dow and Thiokol chemists in the further development of "thiokol" synthetic rubbers, particularly Type N which is especially suitable for tire application. It is apparent, therefore, that "Thiokol" synthetic rubbers, the first practical substitute material, are already alleviating a serious situation threatening the efficiency of our fighting forces and are a bright promise of aid to our civilians in the not too distant future."

AIRPLANE EXPERIMENTS

In the issue of this JOURNAL in May, 1942, the question was asked—

959. Why does an airplane fly?

Do you have a simple explanation? and What experiments do you use?

Answer found in Science News Letter, *pages 232–3, for October 11, 1941.*

Joseph H. Kraus, Science Clubs of America Editor, gives some very interesting experiments in the article quoted. He says: " . . . Scientists have established that two-thirds of the lift of an airplane's wings is produced by a partial vacuum above the wings, the other third of the lift results from air pressure under the wings.

"Nevertheless, with only the simplest of materials, we can demonstrate some of the physical laws which apply to aerodynamics. . . . "

(Then follows the description of the experiments together with a series of diagrams illustrating them.)

This fall, 1942, why not draw your demonstrations for fundamental physical and chemical principles from applications of the principles to the War?

REQUESTS BY READERS

(Under this heading will be carried the names of those who wish to be put in the way of "Keeping Up With Industry.")

950. *Requests on "How to Keep Up With Science and Industry in 1942."*

New Requests—

9. L. E. Wilkins, Deep Springs Junior College, Deep Springs, Cal.
10. Miss Lillian A. MacDonald, South Side High School, Newark, N. J.
11. Dr. Newton C. Jones, E. I. duPont de Nemours, Wyandotte, Mich.
12. Arthur O. Baker, Supervisor of Science Instruction in the Junior and Senior High Schools, Cleveland, Ohio.

Additional Trade and Other Publications—

29. "Marvels and Mysteries of Science"—Published (or to be published) by Wm. H. Wise & Co., New York.
30. "How to See at Night"—Our Second Kind of Eyes for Night Vision Enable us to see Our Way in Blackouts and Against Enemy—by Marjorie Van De Water, in *Science News Letter*, page 358, for June 6, 1942.
31. "Fluorescent Lighting in the Home"—a booklet by The Electrical League of Cleveland. You can probably obtain a similar booklet from your local Electric Illuminating Co.
32. "Streamlined College Course Recommended for Pre-Training" (Aviation Personnel), *Science News Letter* (page 163) for March 14, 1942.

A STUDY OF FALLING BODIES

937. *Submitted by Carolyn Atkins (GQRA, No. 411), Dayton H.S., Dayton, Ky.*

This question and experiments were published on page 893 of the December number of SCHOOL SCIENCE AND MATHEMATICS, 1941.

The question amounts to the old one of Aristotle's—"Is the speed of a falling body proportional to its weight?"

Answer by Paul Wortzel, pupil in South Side High School, Newark, N. J. (Elected to the GQRA, No. 431.) NB—The pupil does not agree with Aristotle.

In explaining why two things of the same weight will not uniformly hit the ground, or, in other words, one will fall faster than the other, let us take for example a penny and a crumpled piece of paper of the same weight as the penny. As they both fall through the air, the force of gravity will bring them down with equal force but air will catch in the folds of the paper and slightly counteract the gravitational pull. Just as a man coming down to earth in a parachute, the force of the air pushing up against the open parachute counteracts the force of gravity and slows up the speed of the man. But, if the parachute is ripped and is put out of use, the man will resume his natural falling speed and be killed when he hits the ground. So it is with the paper, as it falls, the air catches in its folds and slows up its falling speed while the penny has very little resistance to slow its

falling speed, and therefore falls much faster than the paper. In a vacuum there is no air to hold back the fall of the paper and counteract the pull of gravity and the penny and the paper will fall with equal speed and hit the ground together."

Could you give as good an answer when you were in school?

THE COW JUMPED OVER THE MOON

952. *From "Brain Teasers" edited by F. Bevington, in the* Double Bond *of the Western New York Section of the American Chemical Society.*

Find how much work was done when the cow jumped over the moon. (Her weight in pasture was 900 lb; but, as she went up, her weight varied inversely as the square of the distance from the center of the earth, and this distance varied from 4,000 miles in the pasture to 240,000 miles at the moon.) *Answer* is 1,770 mile-tons.

Answer by Hollis D. Hatch, GQRA 264, English High School, Boston, Mass.

"In your issue of SCHOOL SCIENCE AND MATHEMATICS for April, 1942, the answer 1,770 mile-tons was given (page 391) to "how much work was done when the cow jumped over the moon." I have checked this problem and find the answer just right—for the approximate data given—*if* you forget the moon. In other words it is the work done by the cow to jump as high as the moon but not *to* or *over* it. If she went to the moon, this answer is too small.

"A little figuring with the inverse square law shows that at a neutral point 216,000 miles from the earth the cow would be equally attracted by the earth and the moon. The work to get her there, I figure, is 1,760 mile-tons. From there on no work is needed to move the cow towards the moon. If she lands on the moon and jumps off, she does 810 mile-tons against the moon's attraction to get back to the neutral point. From there back to the earth no work need be done; she just falls.

"For the above I used the data given and the moon's diameter as 2,160 miles; its gravity one-sixth and its mass one-eighty-first that of the earth. All the data are somewhat approximate.

"The total amount of work, i.e., 2,570 mile-tons, is so different from your answer that I venture to prefer mine. You might say mine is wrong because neither of us had the cow jump *over* the moon nor considered that both the earth and moon were moving. If you want to figure on this last basis, you will have to ask someone else."

(*Now the bars are down and let those who have worked on cows enter the rodeo and decide which answer, if either, should be regarded as correct.* ED. JONES.)

Teachers, pupils, classes, and individuals are invited to answer questions proposed either by others or by themselves and to propose any questions on any portion of the field of science that they believe will be interesting, or stimulating, or valuable to teachers, pupils, or general readers.

We shall endeavor to get answers to all reasonable questions and ask you to speculate on any that do not seem reasonable. It is always valuable to receive and publish the questions whether answers are available or not.

Classes and teachers are invited to join with others in this co-operative venture in science.

Contributors to SCIENCE QUESTIONS are accepted into the GQRA (Guild of Question Raisers and Answerers). 431 are now members!

NEW MEMBERS OF THE GQRA

423. *Miss Annelyn Day, Sec'y, Science Club, Wilson Junior College, Chicago*
424. *Walter Troll, Wilson Junior College, Chicago, Ill.*
425. *Ernest Lang, Same.*
426. *Harry Delfs, Same.*
427. *Elliott Shubert, Same.*
428. *Harland M. Bright, Head, Dept. of Science, West High School, Cleveland, Ohio.*
429. *Paul D. Thomas, U.S. Coast & Geodetic Survey, Lucedale, Miss.*
430. *Arthur O. Baker, Supervisor of Science in the Junior and Senior High School, Cleveland, Ohio.*
431. *Paul Wortzel, Pupil, South Side High School, Newark, N. J.*

JOIN THE GQRA!

GQRA Members in War Work

What are 431 members of the GQRA doing in the War Effort?

Please send in a mention of your activity whether it is in the armed forces, or war industry, or teaching war subject classes, or Air Raid Warden, or First Aid, or whatever it may be.

BOOKS RECEIVED

INTRODUCTION TO THE THEORY OF RELATIVITY, by Peter Gabriel Bergmann, *Member, Institute for Advanced Study, 1936–1941, and Assistant Professor of Physics, Black Mountain College.* Cloth. Pages xvi+287. 14.5 ×22.5 cm. 1942. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $4.50

ELEMENTS OF SPHERICAL TRIGONOMETRY, by James E. Thompson, Department of Mathematics, *School of Science and Technology, Pratt Institute.* Cloth. Pages xi+144. 13.5×20 cm. 1942. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $1.65.

GENERAL CHEMISTRY FOR COLLEGES, by B. Smith Hopkins, *Professor, Emeritus, of Inorganic Chemistry, University of Illinois.* Third Edition. Cloth. Pages vi+758. 14.5×22 cm. 1942. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $3.80.

CONSERVATION OF NATURAL RESOURCES, by George T. Renner, *Professor of Geography, Teachers College, Columbia University and Consultant, U. S. National Resources Planning Board.* Cloth. Pages xi+228. 15×23 cm. 1942. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $2.75.

GENERAL TRADE MATHEMATICS, by E. P. Van Leuven, B.S. *Department of Mechanical Arts, Kern County Union High School and Junior College, Bakersfield, California.* Cloth. Pages x+575. 15×23 cm. 1942. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y.

PHYSICS, by Frank L. Robeson, *Professor of Physics, Virginia Polytechnic Institute.* Cloth. Pages ix+819. 15×23.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $4.50.

LOGARITHMS, TRIGONOMETRY, STATISTICS, by Hollis R. Cooley, Palmer H. Graham, Frederick W. John and Arthur Tilley all of the *Department of Mathematics, Washington Square College of Arts and Science, New York University*. Cloth. Pages xii+280. 15×23 cm. 1942. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.00.

AIR NAVIGATION, PART I and PART II, by General Editor, E. Molloy. Cloth. Part I pages viii+128. Part II, pages viii+132. 13.5×21.5 cm. 1942. Chemical Publishing Company, Inc., 234 King Street, Brooklyn, N. Y. Price each $2.50.

THE STEEL SQUARE, by Noel D. Green. *A.M.I.Mech.E. Plant Engineer*, Cloth. 88 pages. 13.5×21.5 cm. 1942. Chemical Publishing Company, 234 King Street, Brooklyn, N. Y. Price $2.50.

THE SUPERHET MANUAL, Edited by F. J. Camm, *Editor of "Practical Wireless," "Practical Engineering," and "Practical Mechanics."* Cloth. 135 pages. 13.5×21.5 cm. 1942. Chemical Publishing Company, 234 King Street, Brooklyn, N. Y. Price $2.50.

THE MATHEMATICS OF WIRELESS, by Ralph Stranger. Revised and Enlarged. Cloth. 215 pages. 13.5×21.5 cm. 1942. Chemical Publishing Company, 234 King Street, Brooklyn, N. Y. Price $3.00.

THW "PARTICLES" OF MODERN PHYSICS, by J. D. Stranathan, Ph.D., *Professor of Physics and Chairman of the Department, University of Kansas*. Cloth. Pages xvi+571. 15×23 cm. 1942. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price $4.00.

ESSENTIALS OF ASTRONOMY, by John Charles Duncan, Ph.D., *Professor of Astronomy in Wellesley College*. Cloth. Pages vii+181. 14×21.5 cm. 1942. Harper and Brothers, 49 East 33rd Street, New York, N. Y. Price $1.85.

FROM COPERNICUS TO EINSTEIN, by Hans Reichenbach. Translated by Ralph B. Winn. Cloth. 123 pages. 15×23.5 cm. 1942. Alliance Book Corporation, 212 Fifth Avenue, New York, N. Y. Price $2.00.

FIRST-YEAR ALGEBRA, by Herbert E. Hawkes, Ph.D., *Professor of Mathematics in Columbia University;* William A. Luby, *Professor of Mathematics and Chairman of the Department in the University of Kansas City;* and Frank C. Touton, Ph.D., *Former Professor of Education in the University of Southern California*. Cloth. Pages vii+495. 12×19 cm. 1942. Ginn and Company, Statler Office Building, Park Square, Boston, Mass. Price $1.40.

NEW PRACTICAL CHEMISTRY, by Newton Henry Black and James Bryant Conant. Revised Edition. Cloth. Pages x+683. 12.5×20 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.20.

INTRODUCTION TO SEMIMICRO QUALITATIVE CHEMICAL ANALYSIS, by Louis J. Curtman, *Professor of Chemistry, Chairman of the Division of Qualitative Analysis, The City College—The College of the City of New York*. Cloth. Pages x+377. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.75.

METHODS OF TEACHING IN TOWN AND RURAL SCHOOLS, by E. L. Ritter and L. A. Shephers, *The Iowa State Teachers College*. Cloth. Pages xiii+492. 13×20.5 cm. 1942. The Dryden Press, Inc., 103 Park Avenue, New York, N. Y. Price $2.40.

INTRODUCTION TO PHYSICS, by Harley Howe, *Professor of Physics, Cornell University*. Cloth. Pages xii+559. 15×23 cm. 1942. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $3.75.

SPHERICAL TRIGONOMETRY WITH NAVAL AND MILITARY APPLICATIONS, by Lyman M. Kells, Ph.D., *Associate Professor of Mathematics;* Willis F. Kern, *Associate Professor of Mathematics;* and James R. Bland, *Associate Professor of Mathematics, all at the United States Naval Academy*. Cloth. Pages xiii+163. 15×23 cm. 1942. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $1.50.

INTRODUCTORY COLLEGE CHEMISTRY, by Horace G. Deming, *Professor of Chemistry, University of Nebraska*. Second Edition, Completely Revised, in Collaboration with B. Clifford Hendricks, *Professor of Chemistry, University of Nebraska*. Cloth. Pages xii+526. 14.5×23 cm. 1942. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $3.00.

BASIC COLLEGE MATHEMATICS, by Carl Wallace Munshower and James Fletcher Wardwell of *Colgate University*. Cloth. Pages xi+612. 15×23.5 cm. 1942. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. Price $3.20.

LIVING CHEMISTRY, by Maurice R. Ahrens, *Supervisor in the Department of Instruction, Denver Public School;* Norris F. Bush, *Principal, Eagleton School, Denver;* and Ray K. Easley, *Boys' Adviser, Lake Junior High School, Denver Public Schools*. Cloth. Pages vi+528+xvii. 19.5×25.5 cm. 1942. Ginn and Company, Statler Office Building, Park Square, Boston, Mass. Price $2.28.

THE SCIENCE OF HEALTH, by Florence L. Meredith, B.Sc., M.D. Professor of Hygiene, Tufts College. Cloth. Pages xi+427. 15×23 cm. 1942. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price $2.50.

PUBLIC SCHOOL BROADCASTING TO THE CLASSROOM, by Carroll Atkinson, Ph.D. Cloth. 144 pages. 12.5×19.5 cm. 1942. Meador Publishing Company, 324 Newbury Street, Boston, Mass. Price $1.50.

BROADCASTING TO THE CLASSROOM BY UNIVERSITIES AND COLLEGES, by Carroll Atkinson, Ph.D. Cloth. 128 pages. 12.5×19.5 cm. 1942. Meador Publishing Company, 324 Newbury Street, Boston, Mass. Price $1:50.

RADIO PROGRAMS INTENDED FOR CLASSROOM USE, by Carroll Atkinson, Ph.D. Cloth. Pages 128. 12.5×19.5 cm. 1942. Meador Publishing Company, 324 Newbury Street, Boston, Mass. Price $1.50.

TRIGONOMETRY (PLANE AND SPHERICAL), by Miles C. Hartley, *University High School, University of Illinois*. Cloth. Pages v+298+24. 13×20.5 cm. 1942. The Odyssey Press, Inc., 386 Fourth Avenue, New York, N. Y. Price $1.60.

DIFFERENTIAL EQUATIONS, by Max Morris, Ph.D., and Orley E. Brown, Ph.D., *Associate Professors of Mathematics, Case School of Applied Science*. Revised Edition. Cloth. Pages xi+355. 15×23 cm. 1942. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $3.00.

PRINCIPLES OF RADIO, by Keith Henney, *Editor, Electronics Author, Electron Tubes in Industry, Editor, Radio Engineering Handbook, Member, Institute of Radio Engineers*. Fourth Edition. Cloth. Pages xii+549. 13×19.5 cm. 1942. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $3.50.

PHYSICAL SCIENCE, by William F. Ehret, *Editor, Professor of Chemistry;* Leslie E. Spock, Jr., *Associate Professor of Geology;* Walter A. Schneider, *Associate Professor of Physics;* Carel W. Van Der Merwe, *Professor of Physics;* Howard E. Wahlert, *Instructor in Mathematics, all of Washington Square College of Arts and Science, New York University.* Cloth. Pages x+639. 15×23.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $3.90.

ADVENTURES IN SCENERY, by Daniel E. Willard, A.M., *Fellow American Geographic Society, Fellow A.A.A.S.* Cloth. Pages x+438. 17×25 cm. 1942. The Jaques Cattell Press, Lancaster, Pa. Price $3.75.

MATHEMATICS FOR TECHNICAL TRAINING ALGEBRA, by Paul L. Evans, *Instructor in Mathematics, Engineering Division, Curtiss-Wright Technical Institute, Glendale, California.* Cloth. Pages viii+126. 14×20.5 cm. 1942. Ginn and Company, Statler Office Building, Park Square, Boston, Mass. Price $1.25.

MATHEMATICS FOR TECHNICAL TRAINING, PLANE TRIGONOMETRY WITH TABLES, by Paul L. Evans, *Instructor in Mathematics, Engineering Division, Curtiss-Wright Technical Institute, Glendale, California.* Cloth. Pages viii+108+84. 14×20.5 cm. 1942. Ginn and Company, Statler Office Building, Park Square, Boston, Mass. Price $1.25.

MATHEMATICS FOR TECHNICAL TRAINING, CALCULUS, by Paul L. Evans, *Instructor in Mathematics, Engineering Division, Curtiss-Wright Technical Institute, Glendale, California.* Cloth. Pages vii+126. 14×20.5 cm. 1942. Ginn and Company, Statler Office Building, Park Square, Boston, Mass. Price $1.25.

SUBMARINES, by Herbert S. Zim, Ph.D., *Head of the Science Department at one of the New York Ethical Culture Schools.* Cloth. Pages xii+306. 14×21 cm. 1942. Harcourt, Brace and Company, 383 Madison Avenue, New York, N. Y. Price $3.00.

PARACHUTES, by Herbert S. Zim, Ph.D., *Head of the Science Department at one of the New York Ethical Culture Schools.* Cloth. Pages xii+252. 14×21 cm. 1942. Harcourt, Brace and Company, 383 Madison Avenue, New York, N. Y. Price $2.50.

SPHERICAL TRIGONOMETRY AND TABLES, by William Anthony Granville, Ph.D., *Formerly President of Gettysburg College.* Revised by Percey F. Smith, Ph.D., *Professor of Mathematics in Yale University,* and James S. Mikesh, B.A., *Master in Mathematics in Lawrenceville School.* Cloth. Pages viii+270+iv+43. 15×23 cm. 1942. Ginn and Company, Statler Office Building, Park Square, Boston, Mass. Price $1.25.

BASIC HORTICULTURE, by Victor R. Gardner, *Professor of Horticulture, Michigan State College.* Cloth. Pages x+441. 15×23.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $3.75.

DIFFERENTIAL AND INTEGRAL CALCULUS, by Harold Maile Bacon, Ph.D., *Assistant Professor of Mathematics, Stanford University.* Cloth. Pages vii+771. 15×23 cm. 1942. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $3.75.

RADIO CODE MANUAL, by Arthur R. Nilson, *Chief Instructor, Nilson Radio School, New York, N. Y.* Cloth. Pages xii+174. 12.5×19 cm. 1942. McGraw-Hill Book Company, 330 W. 42nd Street, New York, N. Y. Price $2.00.

THE DEVELOPMENT OF INFORMAL GEOMETRY, by Robert Coleman, J., Ph.D., *Teachers College, Columbia University Contributions to Education, No. 865.* Cloth. Pages xii+178. 14.5×23 cm. 1942. Bureau of Publications, Teachers College, Columbia University. New York, N. Y. Price $2.10.

MODERN SCIENCE IN OUR ENVIRONMENT, by Charles E. Dull, *Supervisor of Science for the Junior and Senior High Schools of Newark, New Jersey and Head of the Science Department in the West Side High School;* Paul B. Mann, *Head of the Biology Department in the Evander Childs High School in New York City;* and Philip G. Johnson, *Editorial Consultant for the Modern Science Series and Assistant Professor of Education at Cornell University, Ithaca, New York.* Cloth. Pages viii+432. 13.5×20.5 cm. 1942. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y.

MODERN SCIENCE IN OUR DAILY LIFE, by Charles E. Dull, *Supervisor of Science for the Junior and Senior High Schools of Newark, New Jersey and Head of the Science Department in the West Side High School;* Paul B. Mann, *Head of the Biology Department in the Evander Childs High School in New York City;* and Philip G. Johnson, *Editorial Consultant for the Modern Science Series and Assistant Professor of Education at Cornell University, Ithaca, New York.* Cloth. Pages viii+502. 13.5×20.5 cm. 1942. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y.

MODERN SCIENCE IN MAN'S PROGRESS, by Charles E. Dull, *Supervisor of Science for the Junior and Senior High Schools of Newark, New Jersey and Head of the Science Department in the West Side High School;* Paul B. Mann, *Head of the Biology Department in the Evander Childs High School in New York City;* and Philip G. Johnson, *Editorial Consultant for the Modern Science Series and Assistant Professor of Education at Cornell University, Ithaca, New York.* Cloth. Pages ix+598. 13.5×20.5 cm. 1942. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y.

THE STONE THAT BURNS, by Williams Haynes. Cloth. Pages xii+345. 13.5×21 cm. 1942. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $3.75.

ESSENTIALS OF PLANE AND SPHERICAL TRIGONOMETRY, by Atherton H. Sprague, *Professor of Mathematics, Amherst College.* Paper. Pages ix+169. 14.5×23 cm. 1942. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $1.35.

BOOK REVIEWS

ELEMENTS OF THE DIFFERENTIAL AND INTEGRAL CALCULUS, Revised Edition, by William Anthony Granville, Ph.D., LL.D., *Formerly President of Gettysburg College;* Percey F. Smith, Ph.D., and William Raymond Longley, Ph.D., *Professors of Mathematics, Yale University.* Cloth. Pages xi+556. 16×24 cm. Ginn and Company, Boston, Mass. Price $3.60.

This is a revision of a text so well known that it seems only necessary to comment on the changes. One immediately apparent addition is that of a fairly comprehensive chapter on hyperbolic functions. In the matter of notation one now finds $\ln x$ for the natural logarithm. The preface calls attention to verbal changes in the details of some of the proofs and similarly

in discussions. Such changes are not extensive, in some places one might wish for further clarification, for example in the discussion of Newton's method of approximating roots of an equation one gathers from the discussion that if a root is between a and b, one may apply the method at either a or b without restriction. Again in the study of fluid pressure some would ask that force and pressure not be considered identical.

Although there is beyond any question much additional problem material, from the point of view of the teacher who is well satisfied with the text in the previous edition there has not been enough change. If one selects pages of problems at random, it is not unusual to find from a fourth to a third of the problems identical with those in the last edition, and in other changes any student with access to his fraternity files will find the problem essentially worked in last year's set. It seems unfortunate that a more complete revision of problems was not undertaken.

CECIL B. READ
University of Wichita

CALCULUS, by Alfred J. Nelson, *Professor of Mathematics;* Karl W. Folley, *Associate Professor of Mathematics;* and William M. Borgman, *Assistant Professor of Mathematics, Wayne University.* Cloth. Pages x×356. 15×23.5 cm. 1942. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $2.75.

By restricting the material to powers of polynomials, the text permits the taking up of both differentiation and integration early in the course. At first it seems a somewhat radical innovation to treat, before introducing formulas for the differentiation of a product, a quotient, or an implicit function, such topics as higher derivatives, points of inflection, areas, the fundamental theorem, centers of gravity, moments of inertia, work, etc. However, the attempt is very successful, although the more detailed study of several of the topics is reserved for later chapters.

The material covered is that found in most elementary texts. There is a chapter on hyperbolic functions and one on elementary differential equations. Tables included are of natural logarithms, exponential and hyperbolic functions, natural trigonometric functions in radians, and a rather brief table of integrals (82).

The reviewer has recently analyzed several calculus texts, since a change of text is contemplated. This text rates exceptionally high as to number of illustrative examples, number and type of problems, and clarity of explanations. Possible weaknesses are the lack of any collection of formulas from algebra, geometry, and trigonometry; brief treatment of more difficult integration problems; and the omission of certain minor topics such as the mean value of a function. From the point of view of using the calculus as a tool, certain features are of value: the absolute value of the logarithm is used in integration formulas; theorems on algebraic operations with power series give the student some idea of the interval of convergence of the resulting series; the material on fluid pressure does not consider force as identical with pressure; at various points emphasis is placed upon the concept of significant figures.

No one interested in a text which introduces integration early in the book can afford to omit examination of this text.

CECIL B. READ

ESSENTIALS OF TRIGONOMETRY WITH APPLICATIONS, by David Raymond Curtiss and Elton James Moulton, *Professors of Mathematics, Northwestern University.* Cloth. Pages viii+174+94. 23×15.5 cm. D. C.

Heath and Company, Boston, Mass. 1942. Price $2.25. Bound with HEATH'S LOGARITHMIC AND TRIGONOMETRIC TABLES, Revised Edition, by Earnest Jackson Oglesby, *Professor of Engineering Mathematics, University of Virginia* (94 pages)

The first five chapters, except for minor changes, correspond with the first five chapters of the authors' *A Brief Course in Trigonometry*. The order of treatment is the general angle first, followed by solution of right triangles, reduction formulas, line values, graphs, identities, radian measure, inverse functions, and equations. The material continues with solution of oblique triangles. There is a chapter of 26 pages on spherical trigonometry, and one of 24 pages on applications. Included in the applications is material on surveying, artillery problems, the mil as a unit of measurement, and navigation. The celestial sphere and the astronomical triangle are treated briefly.

There is an ample supply of problems, with answers to the majority of the odd numbered examples. The material is so arranged that many sections could be omitted if desired. With the present emphasis upon trigonometry, particularly certain of its applications, this text may find considerable use. There remains a faint impression, however, that some of the material could have been placed so that it appears an integral part of the course, rather than an afterthought.

CECIL B. READ

PLANE AND SPHERICAL TRIGONOMETRY, by Paul R. Rider, Ph.D. *Professor of Mathematics, Washington University*. Cloth. Pages xiv+273. 22×14.5 cm. The Macmillan Company, New York. 1942. Price $2.00.

In considering a text in trigonometry, one is interested in the order of treatment of topics. In this text, the acute angle is taken up before the general angle; applications, including the solution of oblique triangles, precede the work on trigonometric formulas and identities, radian measure, and graphic representation. There is more material than would be needed for a minimum course, and the supply of problems is large enough to allow assigning different problems in successive years. There is a brief unit on the mil as a unit of angular measurement.

Tables are not bound with the book, a very brief (four page) four place table of natural functions is in a pocket at the back of the book. Answers are provided to the odd numbered problems, and are available for the even numbers.

The book seems quite teachable, the typography is pleasing. Illustrative examples of logarithmic solution always use cologarithms, which might be objectionable if one prefers not to make use of them.

CECIL B. READ

INTRODUCTION TO PHYSICS, by Harley Howe, *Professor of Physics, Cornell University*. Cloth. Pages xii+559. 15×23 cm. 1942. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $3.75.

Here is a new text for general physics which seems at first to be about 200 pages less than the normal. However, this is not entirely true because the pages are somewhat larger than the average. Moreover, it is not so extensively illustrated as many of the texts, thus giving more space for discussion. It is, however, a text suitable for the average student of physics, presented in a logical manner, for those who want to know the subject. The chapters are short, each one emphasizing one main idea. Each chapter is followed by a rather extensive list of problems; e.g. chapter 5, Circular

Motion, covers nine pages and is followed by twenty-seven questions and problems. Answers are given to a part of the problems. In general the book emphasizes electricity slightly more and the other sections slightly less than many of the other texts on general physics.

The mathematics used by the text consists only of elementary algebra and plane geometry. This makes it possible for the student to take the physics course as a first year subject without having to wait until he has had a year of college mathematics. It also opens the physics course to the many students in other fields who need a knowledge of general physics but do not have time to take the mathematics required by many physics courses. We are pleased to recommend this book.

G. W. W.

THE STONE THAT BURNS, by William Haynes. Cloth. Pages xii+169. 14.5×23 cm. 1942. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $3.75.

This book is the story of the development of the American sulphur industry and shows how this country became the world's greatest source of sulphur. Only those who know of the extensive use of sulphur and of sulphuric acid will fully appreciate it but all will certainly be interested in it. It is a book of the past half century and covers a small section of Louisiana and Texas, but shows the effect on Sicily and the rest of the world. The book is well illustrated and tells the story of the many failures and the final success of the great industry. In some places the author jumps from 1900 to 1940, then back again, but one must not expect too much. The book is well illustrated with many full page pictures that add much of interest and show the development. One wonders why some good maps were not included. The appendix of twenty-nine pages contains many valuable tables.

G. W. W.

HOW TO LOCATE EDUCATIONAL INFORMATION AND DATA, by Carter Alexander, Ph.D., *Library Professor, Teachers College, Columbia University.* Second Edition, Greatly Revised, Improved and Expanded. Paper. Pages xiv+439. 14.5×23.5 cm. 1941. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $4.00.

This book is not only the latest of its kind in the field of research texts but is also the most excellent from the point of view of simplifying the task of locating educational information and data. This second edition, greatly revised, improved and expanded, will remove the sinister aspects and countless difficulties usually encountered by novices in the research processes. It should, if properly used, provide educators and students of education with the "master key" of knowledge which opens the doors of facts and data as yet untouched by thousands who have been groping blindly in their search for new information.

The author's specific justifications of the text may be summarized as follows:

First, the desire to provide working knowledges and skills necessary for the locating of educational information.

Second, to help the educator keep up to date with the rapid improvements in library searching technique.

Third, to help remove the difficulties encountered in obtaining material published in widely scattered places.

Last of all it serves to acquaint one with a vast number of indexes which will enable one to utilize effectively all available library materials.

An interesting feature of this publication is the set of units of library experiences which accompanies this edition. These units provide practical drills and exercises in every known phase of educational research. Here is a text which is admirably adapted to the library needs of every educator and should be one of the *must books* in every schoolman's library.

JOHN P. ALVIR
Phillips High School
Chicago, Illinois

SYMPOSIUM ON DIAMONDS, by Edward H. Kraus, Sydney H. Ball, Lazare Kaplan, Paul L. Hertz, Alexander Shayne, Chester B. Slawson, A. A. Klein, Harry Berman. A Reprint from The American Mineralogist, 27, 162–191 (1942). Conducted as part of the program of the annual meeting of the Mineralogical Society of America, Boston, Mass., Dec. 30, 1941.

As would be immediately inferred from the distinguished character of the roll of authors, this series of monographs is both interesting and authoritative. After Prof. Kraus' introduction, as Chairman, Sydney H. Ball discusses "Diamond Production" which he is probably in better position to know about than almost any other man. Lazare Kaplan, who cut the famous Jonker diamond some years ago then tells of the "Cutting of Diamonds." Paul L. Hertz of New York deals with "Diamonds in the Wire-drawing Industry." This paper is illustrated with three excellent cuts. "Diamond Dies in the National Defense Program" is Alexander Shayne's subject and Prof. Chester B. Slawson of the University of Michigan has "Diamond Set Tools" as his topic. A figure illustrates one such tool. "Bonded Diamond Wheels" handles a comparatively new and rapidly growing mechanical use of diamonds as told by A. A. Klein of the Norton Co., Worcester, Mass., and Harry Berman of Harvard University concluded the symposium with an excellent discussion of "Evaluation Criteria" in which he is concerned with the factors that make industrial diamonds more or less durable and valuable.

Many of our readers should covet a copy of this most unusual reprint. While no suggestion is given as to a possible source of such a supply it might be that a few copies could be had on application to an author or to the publishers of the *American Mineralogist*.

FRANK B. WADE

GLIDERS FOR EVACUATION OF WOUNDED

Gliders and small liaison-planes, capable of landing on little emergency fields or even on highways, lend themselves to probable use, in addition to transport planes, by the new Air Evacuation Group (Medical) which will operate under Brig. Gen. David N. W. Grant, the Air Surgeon, to speed the trip of wounded troops out of the fighting area, it is predicted in American Aviation.

An average transport, with two gliders, it is pointed out, could carry in tons of vital supplies to fighting forces and take out scores of wounded on each trip. Each evacuation will be under the direction of a flight surgeon, trained in the selection of cases and conversant with the effects of air travel. Each of the larger planes will also carry an Army nurse and one trained Medical Corps enlisted man.

Facilities to train the enlisted personnel for this special work will soon be set up.

MOTION PICTURES (16 mm. sound) FOR DEFENSE TRAINING

LYLE F. STEWART

Produced by the U. S. Office of Education, Washington. Distributed for the Government by Castle Films—Field Building, Chicago; 30 Rockefeller Plaza, New York; Russ Building, San Francisco. The price per subject is figured at the basic rate of $.02 per 16 mm. foot film, plus a norminal charge for the reel and container.

The United States Office of Education has developed a series of motion pictures to speed up the training of defense workers. These films were planned and designed by experienced shop instructors. They are technically and photographically excellent, and are outstanding as instructional aids.

Many of these films may be used to advantage in science and mathematics classes. Films such *as Steel Rule, Micrometer, Fixed Gages, Vernier Scale, Height Gages and Standard Indicators, Plain Indexing and Cutting a Spur Gear,* not only facilitate the regular work in physics and mathematics classes but also demonstrate the relationships between these subjects and the work in industry and war production.

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16. Rough Facing, Turning and Drilling on a Vertical	1125
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29. The Deck: Setting a Web Frame and a Transverse Beam... 625
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32. Bulkhead: Setting a Transverse Watertight Bulkhead into Hull..... 625
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It is of the utmost importance, at this time, that these excellent instructional films be brought to the attention of everyone who is connected with the training of defense workers.

EXTRACTS FROM "A PROGRESS REPORT BY THE PHILADELPHIA REGIONAL COMMITTEE, ON SCIENCE AND MATHEMATICS TEACHING."

Findings

1. The armed forces and industry need vast numbers of young men and women who have a thorough knowledge of mathematics up to and including trigonometry, and at least one year of physics, but few can meet the requirements.
2. Many high school graduates and even college graduates have not taken some of these courses; others who have, cannot use their knowledge without well organized review.
3. Science teaching in many districts is substandard because of inadequately trained teachers or poorly equipped laboratories, or both.
4. There are not enough capable teachers to meet the demands for training the vast numbers of young people needed in the armed forces and industry.

Recommendations

1. Mastery, not "passing," be the goal of teaching and learning.
2. Standards be maintained or increased, specifically in these items:
   a. Colleges raise their standards in preparing teachers of science and mathematics.
   b. State departments of public instruction require adequate instruction to the extent of maintaining and raising requirements for certification of teachers.
   c. Promising undergraduates be encouraged to enter the teaching field and to take additional courses in science and mathematics during the summer.
   d. Teachers of all subjects who have had training in science and mathematics be urged to qualify themselves for certification in these fields. Teachers already qualified be urged to take refresher and advanced courses. Where necessary, federal aid be sought for such training.
   e. Special subsidies be sought to set up and equip school science laboratories where such laboratories do not exist.
3. Curricula be strengthened along the following lines:
   a. All basic mathematics and other courses essential to pre-induction training be immediately made an essential part of the school curricula and be recommended for pupils able to profit by them.
   b. High school graduation requirements be revised immediately to permit and encourage every capable pupil to take algebra, geometry, trigonometry, and physics.
   c. Pupils be given an opportunity to change their selection of subjects

to be followed in the fall of 1942 so that additional emphasis may be placed on science and mathematics.

d. Provision be made for those pupils who desire to obtain mastery of subjects in which they are deficient and also for those who want more training in mathematics and science than is now possible in average classroom work.

e. Graphic and practical problem material be introduced continually into existing courses to direct pupil-thinking toward current military, technical, and scientific activities.

f. Adequate steps be taken to inform pupils, parents, and school officials of the importance of scheduling these essential subjects and of adopting a more serious attitude toward study.

4. Qualified teachers be urged to notify the proper school authorities of their readiness to assist, on a volunteer basis if necessary, in the preparation of trainees.

5. The War Manpower Commission and Selective Service authorities be informed of the imperative need of maintaining and increasing teaching forces and student groups in these fields to permit continuous implementing of the military and industrial establishments.

AIR-AGE EDUCATION SERIES

The publication of seventeen books on aviation education by The Macmillan Company, known collectively as the *Air-Age Education Series*, has proved to be an innovation in the publishing world. Prepared by aviation education research groups at two of the country's leading educational institutions, the Series was stimulated by the Civil Aeronautics Administration and prepared with its cooperation. The official sponsor of the Series is the Institute of the Aeronautical Sciences. The Macmillan Company, which received the contract for publication after competitive bidding, has made the prices of the books extremely low in order to insure their widespread distribution.

The books of the *Air-Age Education Series* fall into several categories. There is a textbook of more than 900 pages in pre-flight aeronautics which is intended for the eleventh and twelfth grade students in high schools. This textbook is suitable for either one-year or two-year courses. A second textbook of nearly 700 pages has been prepared specifically for one-year courses in pre-flight aeronautics also to be offered for eleventh and twelfth grade students. The second book is primarily on the science aspects of pre-flight, but also includes chapters on vocational guidance and the social significance of the Air Age. Teachers' manuals accompanying both these textbooks, making it possible for regular high school science teachers to offer the instruction with a minimum of special preparation.

But it is not only in separate courses in preflight aeronautics that the *Air-Age Education Series* will make its contribution. Aviation materials are collected in textbooks for high school students in the fields of geography, physics, general science, social studies, English, biology, mathematics, meteorology, and industrial arts. The impact of the Air Age upon all these fields is brought to the attention of the students in connection with their regular subjects, and the latter are certain to become more dynamic as a result. In addition, there is a book containing scientific facts about aviation for the use of teachers of elementary school science. Another volume, intended for the use of teachers and administrators, explains the entire Series and the reasons for it.

AMERICAN EDUCATION WEEK 1942

Education for Free Men is the theme of the 22nd annual observance of American Education Week. This theme is most fitting at a time when the entire world is at war to determine whether freedom or tyranny shall prevail among men.

American Education Week is a time for a concerted effort on the part of all school systems thruout the nation to help the public understand why education is more and not less important as a result of the urgency of the war effort. It is a time for interpreting to the people what the schools are contributing to the war effort and the part that they must play in the peace that is to follow after military victory is achieved.

The National Education Association has prepared materials to assist local school systems in the observance, among which are posters, leaflets, stickers, manuals, plays, and other materials. Write to the National Education Association, 1201 Sixteenth Street, N. W., Washington, D. C.. for complete information.

TROPICAL TREE PRODUCT KEEPS FATS FROM SPOILING

Chemists have been at work on the problem of keeping oily and fatty foods from spoiling. The problem is basically one of keeping oxygen away from the fats, because they become rancid by oxidizing. A good anti-oxidant has been found by Dr. H. S. Mitchell and Dr. H. C. Black of Swift and Company's research laboratories, in a well-known product of tropical American trees, gum guaiac. Two years of large-scale testing have shown it to be highly successful in the preservation of lard and on wrappings for other oily foods. It was suggested as a possible solution for the still unlicked problem of preserving dehydrated pork products.

AHRENS-BUSH-EASLEY

Living Chemistry

A new and unusually attractive book developed through long experiment in the Denver, Colorado, schools. Follows in general the recommendations of *Science in General Education.*

Teaches fundamentals. Motivates learning by showing the functions of chemistry in the pupil's own life. Contains a section on Chemistry in Warfare. Laboratory Manual and Tests available.

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